The Engineer

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THE ENGINEER

A Seven-Day Journal

Naval Architects' and Marine Engineers' Conference 1951

DURING last week the delegates to the International Conference of Naval Architects and Marine Engineers, besides attending the reading of technical papers, have been entertained, together with their ladies, at a number of functions in London. On Tuesday, June 26th, an official luncheon was given by the Institution of Naval Architects and the Institute of Marine Engineers at the Connaught Rooms, and was followed in the evening by a reception held by the First Lord of the Admiralty on behalf of H.M. Government at Lancaster House. On the following day the members of the conference visited the National Maritime Museum and Painted Hall, Royal Naval College, Greenwich, and were the guests at luncheon of the Shipbuilding Conference. Later there was a reception given by the Lord Mayor at the Mansion House. The proceedings in London concluded with an official dinner at Grosvenor House on Friday, June 29th, the hosts being the Institution of Naval Architects and the Institute of Marine Engineers. Following the loyal toast, Viscount Runciman proposed the toast of "The Guests and Delegates," and made brief reference to the papers read at the meetings. He stated that the object of the Conference was to increase human knowledge, knowledge of each other, and also to help to provide better ships. Quoting Nelson, "Harbour rots good ships and good men," the chairman deplored the appalling waste of shipping, which had been built at high cost and embodied every technical improvement making for maximum efficiency, caused by slow turn round in port, which turned ships into indifferent warehouses. Continuing upon this theme, he said that if all ports were as good as the best ports carrying capacity would be increased by 20 per cent. In his reply, the Belgian Ambassador praised the work done in improving sea communications and stated that civilisation follows the sea. Vice-Admiral Sir Michael M. Denny also replied on behalf of the guests, and announced the retirement of the Director of Naval Construction, Sir Charles S. Lillicrap, who would be succeeded by Mr. V. G. Shepheard. At this point there was a brief ceremony during which Vice-Admiral E. L. Cochrane, U.S.N. (ret.), was presented with Diplomas of Honorary Membership of both the Institution of Naval Architects and the Institute of Marine Engineers. Following this, the Admiral gave the toast of "The Host Institutions," and stressed the need for better ships, higher speed, improved machinery, and finer sea-keeping qualities. Towards attaining these objects, he mentioned the work of such bodies as B.S.R.A., P.A.M.E.T.R.A.D.A., and the National Physical Laboratory as factors in progress. Dr. S. F. Dorey, President of the Institute of Marine Engineers, replied.

A Sulphur Plant at Fawley

IT is announced by the Esso Petroleum Company, Ltd., that a new major plant for the manufacture of sulphur is to be built at Fawley, near Southampton. Work on the plant is to start soon and when it is completed, early in 1953, it is expected to produce about 12,000 tons of 95·5 per cent chemically pure rock sulphur a year. Almost all of this will be available to other industries. This project forms the third stage of construction at the new Esso refinery, now being built at Fawley, which will eventually have an annual output of over 6,000,000 tons of petroleum products. The first two stages comprise the building of the main refinery units for the production of fuels and lubricants. The refinery has been designed to extract from crude oil the maximum quantity of sulphur economically available in the refining operation and, at the same time, to use as little sulphur as possible in its various treating processes. In these processes no sulphuric acid will be used. The plant will convert, by means of a controlled oxidation process, the sulphur which is released in the refining of the crude oil. There has been full co-operation between the company and the Government in organising and planning these facilities. British labour and substantially British materials will be used in the construction and equipment of the plant.

The Simon Group's Research Organisation

THE Simon Engineering Group's new research and development buildings at Cheadle Heath, Stockport, were formally opened on Tuesday last, July 3rd, by Sir Henry Tizard, F.R.S., Chairman of the Advisory Council on Scientific Policy. At a luncheon, prior to the ceremony, the Chairman of the group, Lord Simon of Wythenshawe, said that £250,000 had been spent on the buildings and their equipment and that in the last five or six years the group had received about £25,000,000 of export business from something like forty countries in most parts of the world, including the U.S.A. and Canada. It was realised, Lord Simon continued, that the home and export markets depended upon each other. Export efforts demanded first-rate technical knowledge, which in turn demanded not only an enlarged scientific staff and resources but also a good home market, for which plants immediately accessible for operational study could be built. Concerns like the National Coal Board and the British Electricity Authority might clearly be tempted to design and build much of their own plant, but, Lord Simon said, he hoped they would not take that step, which would deprive firms like his of much of that home market so essential for export business. The nationalised industries, by continuing to place their orders with engineering contractors, and by allowing them to co-operate to the full, would give practical aid to British engineering exports.

County of London Development Plan

A DEVELOPMENT plan for the Administrative County of London, as required by the Town and Country Planning Act, 1947, was presented to the London County Council for approval by the Council's Town Planning Committee on July 3rd. The plan is intended to serve as a guide for all the building and planning activities of the Council, local authorities and other organisations and private developers in the county for the next twenty years, and must be submitted to the Minister of Local Government and Planning for approval by the end of 1951. In preparing the draft plan, the Council has undertaken a considerable amount of research to supplement the data embodied in the County of London Plan prepared for it in 1943. Surveys involving a physical, economic and sociological analysis of the potentialities and future requirements of the county were first carried out and town maps based on the surveys were then prepared. Consultations with committees of the Council, local authorities, statutory bodies and other interested bodies and associations were next arranged, and the town maps reconsidered in relation to individual subjects, such as density of population, education and housing. The plan will be embodied in four main documents: a town map, which illustrates the Council's proposals for the use of land; a programme map, giving a broad indication of the work which the Council expects to see undertaken during the first five years of the plan and the following fifteen years (some longer term proposals of exceptional significance are likely to be included); a written statement—containing information about the proposals illustrated by the two maps, and a report of the survey and written analysis—intended primarily for discussion of the problems brought to light by more than thirty surveys. When the plan is finally presented to the Minister for his approval the documents will be published and placed on sale. Residential areas, which it is proposed to develop in the first five years of the draft plan, total 2430 acres, providing dwellings for 233,000 people and displacement and rehousing of about 70,300 people. Similarly, areas allocated in the first five years for education and open spaces amount to 313 and 480 acres respectively. The proposals for London's roads include six "fly-over" intersections, thirty-seven "roundabout" intersections, 10¼ miles of new principal traffic roads, 7 miles of major widenings of existing routes and 2 miles of new tunnel. Given favourable economic conditions, it is considered that the maximum expenditure which the L.C.C. could undertake during the twenty-year period of the plan would be of the order of £27 million a year.

The Late Mr. George G. Smith

WE have learned with regret of the death of Mr. George Geoffrey Smith, which occurred on Friday last, June 29th, at Pembury, The Avenue, Radlett, Herts. He was a director of the Associated Iliffe Press, Ltd., and for a number of years was managing editor of *Flight*, and other technical journals published by that company. Mr. Smith, who was born in 1885, joined the staff of Iliffe and Sons, Ltd., in 1904, and in 1912 was appointed editor of *The Motor Cycle*. During the first World War, he served in the Royal Air Force, and, after demobilisation in 1919, resumed his career in technical journalism. In the second World War, Mr. Smith was called upon to serve on a number of Government committees, including the Trade and Technical Press Panel of the Ministry of Labour, of which he was chairman. He was the author of several technical handbooks on aircraft, automobile and other subjects, among them being "The Modern Diesel" and "Gas Turbines and Jet Propulsion." Mr. Smith was a Freeman of the City of London, a Liveryman of the Worshipful Company of Coachmakers, a member of the Newcomen Society and a member of the Gas Turbine Co-ordinating Committee of the American Society of Mechanical Engineers. He was also a Past-President of the Circle of Aviation Writers.

British Road Federation

THE annual report of the British Road Federation for the year 1950 has now been published. The report contains details of the action taken by the Federation in connection with the proposals to double the duty on motor fuel and the imposition of 33⅓ per cent purchase tax on commercial vehicles. There is a further reference in the report to the reduction of the number of commercial vehicles made available to the home market and mention is made of the correspondence between the Federation and the British Transport Commission on matters concerning the continued operation of "C" licences.

The South Bank Exhibition

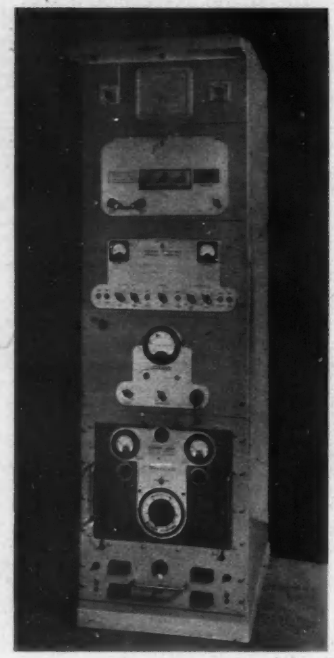
No. X—(*Continued from page 853, June 29th*)

The Radio Telescope

THE use of radio in astronomy is a very recent development. For hundreds of years man has explored space with the help of light alone. When one realises the intricate details of the universe that he has been able to piece together with this one tool, the importance of having another technique at his disposal can hardly be overestimated.

Radio is used astronomically in what might be described as a passive and an active form. The passive form consists of receiving and interpreting signals that emanate from outer space. The active method is to generate high power signals on earth and to receive the echoes reflected from heavenly bodies—a form of celestial radar. This radar technique, as applied to the detection and location of meteor trails, is a development due to Dr. Lovell and his team of research workers at the University of Manchester and is demonstrated in the Dome of Discovery.

The fact that celestial bodies emit radio waves is not, in itself, surprising. Radio waves being but low frequency light waves one would expect radio emission from any heated body, a phenomenon that has been observed in the laboratory. Application of Planck's radiation law enables the energy of this emission to be calculated for any temperature of source. However, it has been found by experiment that radio signals are received from points in the sky where there



Receiver for Solar and Galactic Noise

are no visible stars, and the strength of the signals requires a source temperature greatly in excess of any known star if ordinary physical laws are obeyed. No satisfactory explanation of this phenomenon has yet been put forward. Meanwhile, we describe these points of emission as "radio stars," while carrying out further research in an attempt to understand them.

The radio telescope equipment at the South Bank Exhibition consists of a highly directional aerial array on the top of the old Shot Tower, a very sensitive receiver installed in a special room at the base of the Tower, and a display unit on the Outer Space gallery of the Dome of Discovery.

The aerial array, engineering details of which are given later in this article, consists of a folded dipole aerial and reflector backed by a 30ft paraboloid to obtain high aerial gain and to discriminate against interference arriving in any other than the preferred direction. The signal is fed from the aerial by two low-loss concentric feeder cables of new design to a point high in the Tower, where they are coupled to two non-flexible feeders of similar electrical properties, which carry the signal to the input transformer in the receiver room.

The receiver itself was built by the University of Manchester and operates on about 120 Mc/s (2·5m). The three criteria to be satisfied by such a receiver are: (*a*) very high sensitivity, (*b*) very low self-generated noise, (*c*) extremely high overall stability.

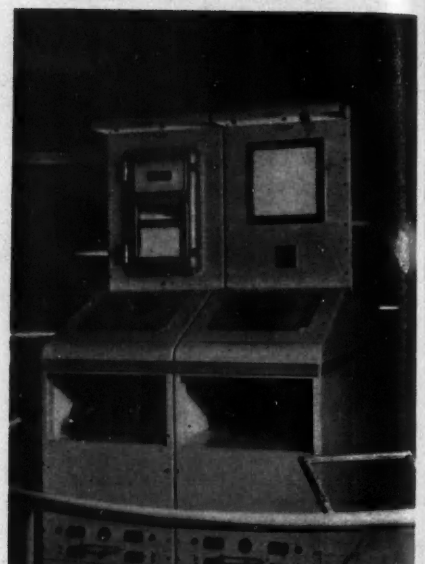
To obtain adequate sensitivity consistent with stability, a super-heterodyne receiver is indicated. Most of the self-generated noise in such a receiver occurs in the mixer; for this reason several stages of radio frequency amplification are used before mixing, so that the optimum signal-to-set-noise ratio is obtained. To prevent hum due to the presence of a.c. on the valve heaters, d.c. heater supplies are used throughout, while h.t. is obtained from a stabilised power pack. "Audio" amplification is obtained from a d.c. amplifier, which is necessary due to the very slow change of intensity of signal as the aerial array is tracked across a source of noise. Even with such a high gain aerial, every precaution being taken against set-generated noise in the design of the equipment, the signal received is only of the order of the local noise. The final signal feeds a pen recorder which is biased back to eliminate receiver noise, so that the record obtained represents only what is received by the aerial. One of our illustrations shows the cabinet housing the receiver and associated equipment for solar and galactic "signals."

The display unit in the Dome is shown in our second illustration. It consists of a simple rack carrying a pen recorder and a monitoring loudspeaker, the latter being particularly valuable as a means of identifying the kind of interference picked up.

A site in the middle of a large city and adjacent to a busy electric railway line is far from ideal for a radio telescope. The height of the aerial above the ground, 200ft, and its highly directional properties cut out the worst of the interference, but there is still a considerable amount of man-made static during the day from factories and offices in the vicinity. Some of this can be eliminated by a diode peak clipper, which operates only on short duration pulses. By far the worst source of interference, however, comes from aircraft radio-telephony systems. The directional properties of the aerial clearly do not materially assist in eliminating this as the aircraft often fly across the aerial beam. Fortunately, the aircraft only radiate carrier waves for relatively short periods at a time, and the traces resulting from these are easy to interpret on the records. Their presence, therefore, while highly undesirable, does not prevent the effects in which we are interested from deing demonstrated.

During most of the day the only source of radio noise available to us is the sun. The emission from the quiescent sun is relatively weak, only just above set noise, but when the sun is active, i.e., when there is a sunspot, the noise level rises sharply. Late in the day two galactic sources come into "view," one in the constellation of Sagittarius and the other in Cygnus; these radio stars give much stronger signals than the sun.

The equipment at the South Bank cannot "pin-point" the position of radio stars to



Radio Telescope Display Desk in the Dome of Discovery

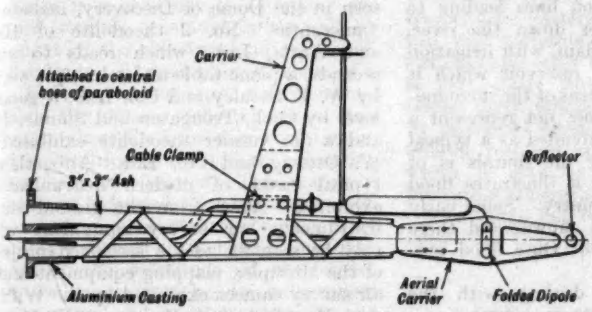
better than a few degrees. Their precise positions have, however, been located either by using very large paraboloids with correspondingly better resolution or by interference methods. The radio telescope displays in the Dome are the first demonstration to the public anywhere in the world of signals from outer space, and they show not only the type of signal received, but also something of the techniques used and the difficulties to be overcome in pursuing a fascinating new line of physical research which seems destined to tell us more of the structure of the universe that we live in.

Aerial and Reflector for the Radio Telescope

The main aerial boom, which is shown in the accompanying illustration, is constructed from four timber members of 3in by 3in ash, mounted in rectangular sockets formed in an aluminium casting, which is bolted to the main reflector bowl. The aerial itself is carried on two "Tufnol" plates fixed at the forward end. Because of dielectric interference, it was essential that these plates were fitted without the use of steel screws or dowels, and therefore fixings were made with "Tufnol" bolts, a few brass screws and marine glue. The dipole carrying plates and cable clamps were fitted in a similar manner. Wind load on the cantilever was minimised by bracing the timbers to form a box-like structure, all joints being sealed against the weather by protective agents not containing mineral. The whole structure is designed so that the maximum deflection at the mirror end will not exceed 0·024in.

The reflector is a paraboloid, 30ft in diameter, made entirely of Duralumin by the

Blackburn and General Aircraft Company. It consists of parallel 10 S.W.G. tubes bent to a standard jig on the assembly floor, and afterwards clamped to the main radial arms of the structure. The two sets of arms are connected at the outer ends of the shorter set by pinning to cast Duralumin brackets. The inner ends are positioned by nuts on the centre bosses to allow for adjustment to the correct angular opening. The arms are further positioned circumferentially by short link rods, all of which, except the last to be assembled, are screwed into position; the final one is pinned. To provide additional rigidity under wind loading, a further set of radial tension rods has been provided, held by nuts to the back end of the rear boss. The outer ends of the reflector rods are electrically connected by a circumferential strip to prevent any possibility of resonance in the rods interfering with the beam.

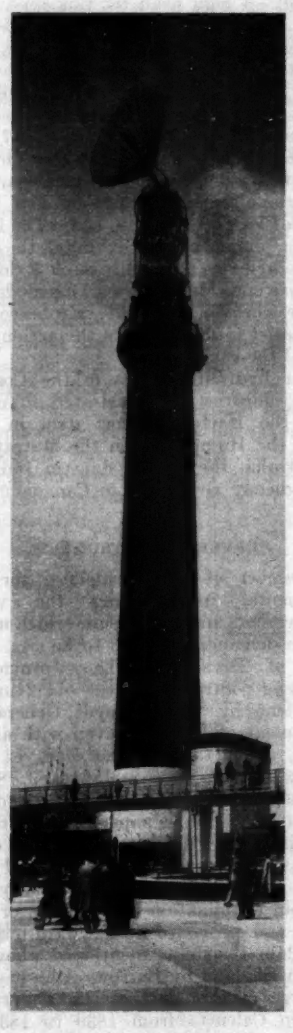


AERIAL BOOM ASSEMBLY

The first assembly of the paraboloid, at the firm's works, was carried out on a vertical jig; it was then stripped down, transported to the site at the base of the Shot Tower, and the second assembly was completed in three days. To direct the paraboloid by remote control, it was fitted on the mounting of a 3·7in anti-aircraft gun, lent to the Festival authorities by the War Office. This mounting was not an ideal mechanism for this purpose, as the servo motors were, of course, not designed for overcoming the kind of wind resistance that might be encountered, but time was the controlling factor, and if a mechanism had had to be designed and manufactured especially for the job there would have been no possibility of achieving it for the Festival year. The motors were designed for a maximum torque of about 1ft/ton, and calculations of wind forces on the paraboloid indicated that it might not operate in a wind of more than 10 m.p.h. Moreover, with a structure of this shape, it was difficult to estimate the direction from which the wind would have most effect. Fortunately, trials have shown that the calculations were unduly pessimistic, and the mechanism can be controlled in any reasonable wind. If high winds occur the gun is clamped and operations cease.

To raise the paraboloid to the top of the Tower, it had first to be turned through 90 deg. This was done by running a boom through it at the estimated centre of gravity, and raising it on jacks till it was clear of the jig pintle. The lifting tackle, which had previously been attached to a circumferential wire rope was then used to bring the paraboloid gradually to its correct position where it was supported on a spreader with lines carried down to the centre boss. Three winches were used for lifting, two for the side ropes and one at the rear, with a rope attached to the gantry at the top of the Tower, to control its luffing motion. The gantry legs were hinged to special lugs welded to the steel framework at the top of the Tower. During lifting, the paraboloid was guided by tension stays passing through loops on the boom and also by ropes held by hand on each side of the Tower and in front. The whole operation of lifting and placing the paraboloid, which with its aerial weighed a little over 3000 lb., and showed a distinct tendency to swing about in the wind, was an operation of some delicacy.

Two cables for the supply of power to the aerial, and the transmission signals to the receivers, were attached to the aerial, but to prevent their weight coming on the paraboloid itself, two clamps were arranged, one near the trunnions of the gun and the other at a fitting fixed to the gun carriage, which allows the cables to hang in loops at the north side of the Tower. The traverse of the gun is limited to an arc of 280 deg. to prevent damage to these loops by excessive tension. Short travel hydraulic stops are normally fitted to this gun, but as the paraboloid and counterweight involved considerable additional inertia, extra spring stops with a travel of 6in were fitted to reduce the risk of damage to the structure if the gun tended to take charge. If, for example, there was a failure in the electricity supply during working, the apparatus would tend to swing like a weathervane—the hydraulic motors would then provide some damping resistance to prevent too high a rate of swing.

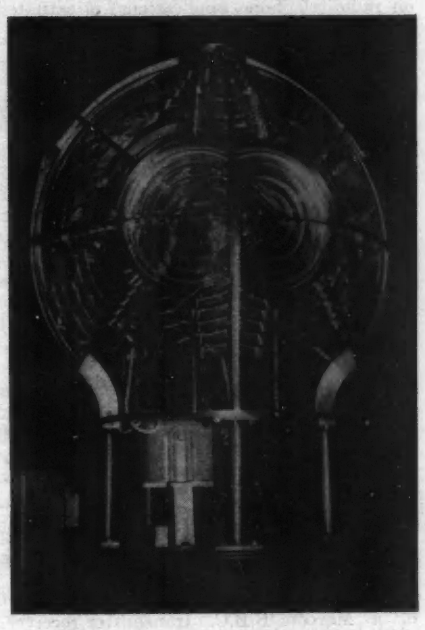


SHOT TOWER

Radio Controlled Lighthouse Lamp

Besides the radio telescope array, which surmounts the Shot Tower, there is a lighthouse lantern, made by Chance Brothers, Ltd. and installed in the structure at the top of the Tower. As a demonstration of the remote control of lighthouses by radio signals, the lamp is arranged to be switched on at sunset and off at midnight, through the medium of a receiver mounted inside the lighthouse lantern and controlled by a transmitter in a building in St. James's Square.

The optical equipment, which is illustrated herewith, consists of a small third-order optic arranged in the form of four panels which condense the light from the source into four beams; the two successive beams are separated by an angle of 36 deg., the angle between the two groups of beams being 144 deg. Rotation of the optical apparatus is provided, through a centrifugal clutch and reduction gearing by an electric motor; a second motor which serves as a standby is arranged to take over automatically upon failure of the service motor. The turntable carrying the optical system runs on ball bearings, the whole unit being mounted on the lantern floor. When the system rotates, a flashing character, recurring every ten seconds, is given to the beam, as follows: white flash, 0·33 seconds; eclipse, 1·33 seconds; white flash, 0·33 seconds; eclipse, 8·01 seconds.



LIGHTHOUSE OPTIC DESIGNED FOR THE SHOT TOWER

The light source is a 3000W, 100V metal filament lamp, and its candle power when the beam is rotating is 3 million international candles. A standby lamp is provided in an automatic lamp changer, which ensures that if the operating lamp should fail the standby is automatically brought into focus and switched on. The luminous range of the beam is given as 47 sea miles, or 54 statute miles, in clear weather.

The revolving optical apparatus containing the light source is mounted inside a standard 7ft 1in diameter lantern with cylindrical glazing. All the switchgear associated with the motor drive, flashing characteristic, the

automatic changeover facilities and the radio circuits, is housed inside the lantern.

For the remote control of the lamp by radio signals, use is made of standard Marconi v.h.f. equipment of the kind that is widely used for communication by radio telephony by police, ambulance and fire services, &c.

In the St. James's Square office is a miniature crystal-controlled transmitter operating on a G.P.O. allocated frequency of 168 Mc/s. A time clock is arranged to switch on the transmitter carrier for a few seconds half-an-hour after sunset each day and again at midnight. A short c.w. pulse is thus sent at these times and is picked up by the receiver on the Shot Tower, lightweight four-element Yagi directional aerials being used at both transmitting and receiving stations. At the top of the Tower is a small highly sensitive crystal-controlled receiver, as illustrated herewith. A relay (normally used in a calling circuit on radio-telephone applications) is actuated

V.H.F. RECEIVER AS USED ON THE SHOT TOWER

by the received pulse and operates an inching relay to switch the light on or off, according to the sequence.

The St. James's Square transmitter is part of a Marconi/B.B.C. transmitter/receiver, type H 111, normally used for amplitude modulated radio telephone work. It can be operated on any one crystal-controlled spot frequency in the band 156 to 184 Mc/s. The whole unit, with its receiver (not used in this present application) and built-in power unit, is 19in wide by 8¼in high by 11¼in deep, and weighs only 34 lb. The Shot Tower receiver is a separate unit of the kind that is usually used with its own 10W transmitter. It can operate on any crystal-controlled spot frequency within any of the recognised bands between 36 and 184 Mc/s. It is 8in wide by 8in high by 16in deep and weighs 15½ lb.

Hydraulic Engineering

In recent years, the exploitation of hydro-electric power has been increasing rapidly, and new works now account for a substantial part of the civil engineering effort of many countries. A stage has now been reached where development is frequently conceived in terms of an entire river catchment, and may be undertaken for other reasons as well as for the generation of power. The so-called "multi-purpose" projects include amongst their aims flood control, the supply of irrigation water, the provision of water supply, or other amenities such as the encouragement of fish or wild life. In these cases, hydraulic works may be carried out in conjunction with other measures, such as the establishment of industries or the improvement of methods of agriculture (particularly if soil erosion has to be guarded against), and the control of water borne diseases, such as malaria, may also be undertaken, so that the health and prosperity of the area is greatly improved. The fundamental importance of such development, particularly in the Commonwealth, is, of course, well suited to the general theme of the Dome of Discovery. The section devoted to this subject includes murals explaining the methods and benefits of river control and development, and there is a model landscape of a river showing the various works along its length which benefit the surrounding countryside—a dam and power station in the mountainous upper reaches, with transmission lines leading to the broader valley lower down the river, where there is a second dam, with irrigation canals leading from the reservoir which it forms, to the cultivated areas of the surrounding plain. The model does not represent a particular river, but is intended as a typical example. One series of the murals is of particular interest, since it illustrates flood protection in the fen country. Some early flood protection work is shown, and there are diagrams of the Great Ouse flood protection scheme.

The central exhibit dealing with the generation of hydro-electric power is a display of three models of the Tekapo hydro-electric scheme in the South Island of New Zealand. There is a model showing the power station, and on a larger scale (one-tenth full size), a fully sectional rotating model of the single turbo-alternator set which it contains. Lastly, there is a full-scale "mock-up" of the turbine runner. The turbine is a Kaplan machine of 30/35,000 h.p., operating at 150 r.p.m., under a head of between 74ft and 96ft—a high head for this type of turbine. It is coupled to a 28MW alternator, which generates at 11kV, three-phase, 50 c/s. The alternator is of the "umbrella" design, having the thrust bearing, which is designed to take a load of 750 tons, below the rotor. The runaway speed of the set is 367 r.p.m. The Tekapo power station is being built by the New Zealand Public Works Department, the turbo-alternator being supplied by the English Electric Company, Ltd. The English Electric Company, Ltd., exhibited the models of the scheme at the South Bank Exhibition, and also a one-third scale working model of an impulse turbine, which is stroboscopically illuminated to demonstrate the action of the jets and the runner.

Other hydraulic works in the Commonwealth countries are illustrated in murals, where the Hartebeestpoort dam in South Africa, the Hume dam on the Murray river in Australia, the Mettur dam in India and the Saguenay river dam in Canada may be seen.

Surveying Instruments

A number of typical modern surveying instruments, incorporating the various improvements and refinements which modern practice demands, are also to be seen in the Dome of Discovery. They provide an interesting contrast with the old 24in theodolite lent by the Surveyor General and Government of India, or even with another exhibit, a Tibetan explorer's prayer wheel which was used, between 1864 and 1875, as an "instrument" in the early exploration of Tibet. The slips of paper carrying records of bearings and distance accumulated during several months, were kept in the head of the prayer wheel, and in this sanctuary were safe from examination by Customs or other officials and provoked no awkward inquiries.

The 24in theodolite mentioned above was made in England by Barrows, who had been in charge of the Mathematical Instrument Office in Calcutta from 1830 to 1837; it was shipped to Calcutta in 1848, and was extensively used for primary triangulation until 1873. After it had been in use for five years, modifications were made to the vertical axis, and the number of microscopes was increased from three to five; later on the microscopes were replaced by others made by Troughton and Simms. The instrument weighs 800 lb when packed. Unfortunately, some damage caused during transit from India could be only partly repaired before the Exhibition opened, so that the instrument is incomplete.

The surveying instruments, which may be seen in the Dome of Discovery, include the "microptic" No. 2 theodolite of Hilger and Watts, Ltd., which reads to single seconds, a plane table and telescopic alidade by W. F. Stanley and Co., Ltd., a geodetic level by Cook, Troughton and Simms, Ltd., and a 5in vernier theodolite exhibited by W. Ottway and Co., Ltd. Altogether, a typical range of modern instruments is exhibited. Apart from the ground survey instruments, air survey equipment which may be seen includes a sectioned projector of the Multiplex mapping equipment and an air survey camera exhibited by the Williamson Manufacturing Company, Ltd., and instruments for radio-controlled flying by survey aircraft by both Cossor Radar, Ltd., and the Decca Navigator Company, Ltd.

The Middle Harbour Bridge, Sydney

Mention should also be made of a model bridge which is shown in this section of the Exhibition, in a section entitled "Commonwealth Links," devoted to the development of transport, including railways, roads and bridges, in the Commonwealth countries. The bridge is to be built at the Middle Harbour in Sydney, and will be situated beside an existing bridge which it is intended to replace. It has been designed by the Department of Main Roads, New South Wales, and a contract for its erection was placed with the Cleveland Bridge and Engineering Company, Ltd., in January of this year, the contract being secured against world-wide competition.

The bridge will be 745ft long, carrying a 44ft wide roadway and two footways over an estuary on the outskirts of Sydney. The superstructure comprises six fixed spans, each of approximately 100ft, and one bascule opening span of approximately 130ft. All the spans consist of deep plate girders of mild steel, welded construction being employed throughout. The steelwork will be protected against corrosion by a coating of zinc, applied by the metallic spraying process.

The opening span will be controlled by an electrically-driven mechanism, suitably interlocked. In the case of failure of the main power supply, a standby electric generator set will be brought into operation, and in addition, a further emergency drive by petrol engine can be used.

The bridge will be carried on abutments and piers founded under the bed of the estuary at a maximum depth of over 100ft below water level. A main pier in the middle of the bridge carries the operating machinery, together with an observation tower in which are situated the controls for operating the bascule span, roadway and footway gates, and all traffic signals. The value of the contract is approximately £550,000, and the work will take four years to complete. The Cleveland Bridge and Engineering Company, Ltd., is carrying out the complete contract, with the assistance of two sub-contractors: J. M. Henderson and Co., Ltd., for mechanical work, and the General Electric Company, Ltd., for the electrical control gear and fittings.

(To be continued)

A Gauge for Measuring Sustained Stresses in Soil*

By A. C. WHIFFIN, Ph.D., M.Sc.(Eng.), A.M.I.Mech.E., and R. T. SMITH

Summary

In many investigations of the foundations of roads, it is necessary to determine the sustained stresses generated in the soil by the weight of the structure and the superimposed loads. A description is given of a gauge for carrying out such measurements, in which the minute deflection of a steel diaphragm alters the tension in a wire maintained in vibration by a valve, thus changing the frequency of vibration. This change of frequency is indicated on a microammeter, whose reading is directly proportional to the pressure applied to the gauge and independent of the amplitude of the signal. The stress gauge gives results independent of temperature and moisture changes, and is unaffected by deterioration of connecting cables or variation of switch contacts and other connections. It is thus more suitable for operating in damp soil over a long period than gauges which operate by varying the amplitude of an electrical signal.

Introduction

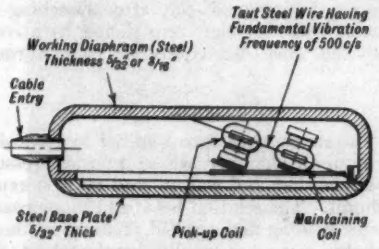
The design of roads and railway tracks is largely based on empirical formulæ combined with tests of an *ad hoc* nature, such as those used for estimating the bearing capacity of the soil beneath the structure. More rational designs could be attempted if the stresses likely to be generated in the soil by the weight of the structure and traffic could be computed, and if the rheological properties of the soil were known. As a first step, it is necessary to determine the stresses generated by various loading systems applied to a number of different soils and to know much more of the mechanical properties of the various materials employed. This requires gauges to be developed capable of measuring the sustained stresses generated in the soil by the superimposed structure and loadings of various kinds. The description of such a gauge is the object of this note. Many gauges suitable for recording the dynamic stresses produced by traffic do not respond to sustained stresses, so that instruments have to be specially designed to record those static stresses in order to determine the total stress to which any point in the soil is subjected.

General Description of the Gauge

Between 1928 and 1935 extensometers were developed in Russia[1], France[2], Germany[3], and Great Britain[4], in which the strain altered the tension on a steel wire and thus changed its frequency of mechanical vibration. In many of these strain gauges the frequency was compared with that of a similar wire stretched by an adjustable, measurable amount, and thus the strain was determined.

The present gauge operates on the "acoustic" principle and comprises a cylindrical steel case having a diaphragm subjected to the soil stress.; the resultant minute deflection of the diaphragm alters the tension in a taut steel wire maintained in vibration by a thermionic valve, and thus changes its frequency. This change is measured by a circuit operating independently of the amplitude of the signal, and thus the gauge and its associated equipment gives results free from errors due to temperature, deterioration of cables, moisture and variation of contact resistance of switches and other connections. This makes it particularly suitable for recording sustained earth stresses, since it is unaffected by prolonged burial in moist soil, and gives reliable readings at long intervals, between which it may be disconnected from the indicating apparatus.

The gauge has certain points of resemblance to the Maihak soil stress gauge


Taut Steel Wire Having Fundamental Vibration Frequency of 500 c/s
Working Diaphragm (Steel) Thickness 5/32" or 3/16"
Cable Entry
Steel Base Plate 5/32" Thick
Pick-up Coil
Maintaining Coil

Overall diameter = 5·50in.
Overall thickness = 1·50in.
Overall compression = 1·26in by 10^{-4}in per pound per square inch when diaphragm is $^5/_{32}$in thick.
Overall compression = 9·9in by 10^{-5}in per pound per square inch when diaphragm is $^3/_{16}$in thick.
Maximum deflection per pound per square inch of :
(*a*) Diaphragm of thickness $^5/_{32}$in = 6·5in by 10^{-5}in.
(*b*) Diaphragm of thickness $^3/_{16}$in = 3·8in by 10^{-5}in.
(*c*) Base plate of thickness $^5/_{32}$in = 6·1in by 10^{-5}in.

Fig. 1—Details of "Acoustic" Stress Gauge

developed in Germany[3] during the last decade, but is smaller and thus less likely to disturb the distribution of stress in a mass of soil. The most recent form of this gauge has not been described in the readily available literature; it may be of interest to describe it briefly here. The gauge is cylindrical in form and is 12in in diameter by 6in high. It contains a steel wire, whose tension is varied by the minute deflection of a diaphragm; this wire is not maintained in vibration but is plucked electrically, and its frequency determined by observing Lissajous's figures on an oscilloscope in the short time elapsing before the wire ceases to vibrate. A number of "pluckings" are needed to achieve a precise measurement; the reading of a stress takes a minute or two and this is frequently inconvenient.

Details of the Road Research Laboratory Gauge

Fig. 1 shows a cross-section of the gauge developed at the Road Research Laboratory. Only one face is operative; this is shown uppermost in the diagram. The diaphragm is of such a thickness that the maximum pressure it has to measure does not produce a central deflection exceeding 0·0005in. The overall diameter of the gauge is 5½in, so that the ratio of diameter to compression is approximately 10,000, which is well above the value of 2000 recommended by D. W. Taylor[5] as the minimum to avoid some of the errors due to the difference between the mechanical properties of the soil and the gauge. Gauges having a larger compression will probably under-register when used in most soils.

The gauge body is of mild steel and a steel wire of 26 S.W.G. is stretched between the approximate centre of the working diaphragm and a screw adjustment near the side. Two electromagnets, each having a resistance of 60 ohms, taken from radio head-phones, are fixed astride the wire, as shown. One electromagnet is connected via a step-up transformer (ratio 1: 15) with the grid of a valve, while the other is connected with its anode circuit via a step-down transformer (ratio 1 : 10), and hence the valve maintains the wire in mechanical vibration. Details of the circuit are given in Fig. 2, which indicates that one wire from each electromagnet is connected with the chassis of the equipment, so that three-core cable is used to connect the gauge with the measuring equipment. The cables are frequently 40ft to 50ft long in road investigations.

The plate shown at the bottom in Fig. 1 forms a water-tight joint. To prevent the gauge acting as a gas thermometer, a gas leak is provided in the centre of the special connecting cable. This cable consists of three flexible leads, each insulated with polyvinyl chloride, twisted together without filling and then wrapped with tape beneath the outer sheathing. The leak is completed by drilling the three-pin plug used to connect the gauge lead with the measuring apparatus. This source of error in completely sealed gauges does not appear to have been discussed hitherto. The volume of air so enclosed will exert a pressure on the working diaphragm depending on the temperature. The error thus introduced is

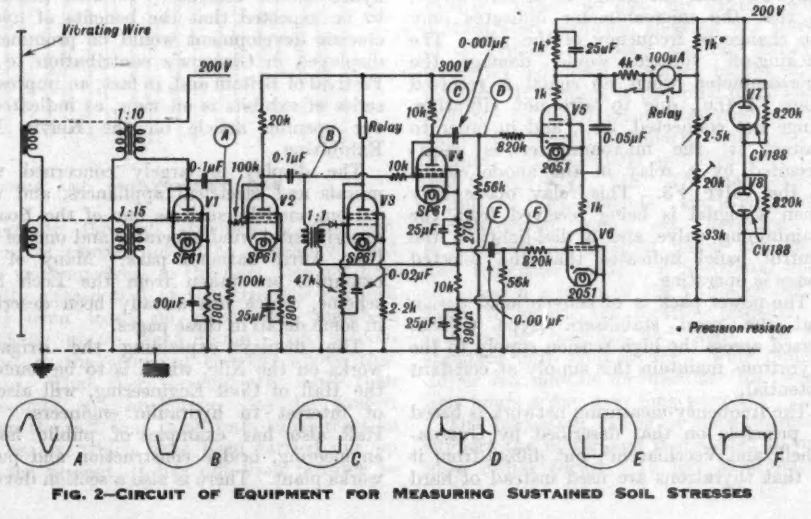


Fig. 2—Circuit of Equipment for Measuring Sustained Soil Stresses

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independent of the sensitivity of the gauge and is of the order of ½ lb per square inch for a temperature rise of 9 deg. Cent. between calibration and use.

The steel wire within the gauge is adjusted to vibrate at 600 c/s when its diaphragm is unloaded. When the diaphragm is loaded under its maximum stress the deflection at the centre of 0·0005in causes the frequency to fall by 40 c/s, and it is this change which is measured.

Measuring Equipment

Full details of the circuits employed are given in Fig. 2. The equipment is contained in the portable box shown in Fig. 3 and is operated from an a.c. mains' supply.

Selector switches are used to connect any one of ten gauges with the maintaining circuit employing valve *V*1. The output from this circuit is fed to the amplifying

Fig. 3—Stress Gauge with Controlling and Measuring Equipment

valves *V*2 and *V*4, by which the signal is amplified so much that it is "squared" and limited to an approximately constant amplitude. The anode of the valve *V*4 feeds the thyratron *V*5 via a differentiating circuit giving pulses, while the cathode circuit of *V*4 feeds the thyratron *V*6 via a similar differentiating circuit. The wave forms at the various stages of the circuit are shown in Fig. 2. The thyratrons are initially biased to be non-conducting and conduct only when fed with a positive pulse. The charging current of the 0·05μF capacitor between the high tension supply and *V*6 depends on the frequency of the pulses received by the thyratrons and is measured on a microammeter of $-10, 0, +100\mu$A range.

A backing-off voltage is applied to the microammeter to cancel the current due to the fundamental frequency of vibration of the wire when the gauge is at zero stress, so that the microammeter indicates only the change of frequency of the wire. The backing-off voltage would damage the microammeter when no signal is received from *V*1 (i.e., due to wire not vibrating, gauge not connected, &c.), and in order to protect it, the microammeter is short-circuited by a relay in the anode circuit of the valve *V*3. This relay opens only when a signal is being received from the maintaining valve and a dial-light on the control panel indicates that the selected gauge is operating.

The power pack is of conventional design and the neon stabilisers (type CV188) placed across the high tension supply to the thyratrons maintain this supply at constant potential.

The frequency-measuring network is based in principle on that described by Guarnaschelli and Vecchiacchi[6], but differs from it in that thyratrons are used instead of hard valves, it being considered that thyratrons are more positive in acting upon a triggering pulse. The other difference is that the present circuit uses a valve phase splitter (*V*4), whereas the earlier circuit employed a transformer with two oppositely wound secondary windings.

Within the range of fluctuations of amplitude of signal experienced, the readings of the microammeter have been found independent of the size of the signal. As a precaution to avoid the effects of possible variations in the behaviour of the precision, temperature-stable resistors in the backing-off circuit, a reference wire was built into the control unit, and can be maintained in vibration by the valve *V*1 by operating an additional selector switch. This wire is held in a steel frame and is free from temperature effects. The backing-off voltage applied to the microammeter is adjusted to bring the instrument to zero when this reference wire is in circuit. In practice, this zero adjustment seems to be needed only when the gauge readings are required immediately after switching on the apparatus, the zero being relatively constant once the equipment has warmed up.

Calibration

The stress gauge is calibrated by enclosing it in an air chamber, whose internal pressure is adjustable, and can be read on a mercury column. The relation between the microammeter reading and applied pressure is linear. In the gauges normally employed at the Laboratory full-scale deflection of 100μA is obtained for an applied pressure of 50 lb per square inch and the sensitivity is increased by short-circuiting a resistor in series with a microammeter to give full-scale deflection at 20 lb per square inch. A gauge can be read in a few seconds, but it must be emphasised that the gauge is not suitable for dynamic measurements because the vibrating wire takes a second or so to settle down at its new frequency after the gauge has been loaded. Moreover, the natural frequency of 600 c/s is not high enough for the gauge to be used to measure transient or cyclic pressure variations occurring at any reasonable frequency.

A gauge has been buried in damp earth for eight months and tested at weekly intervals; it retained its calibration for the whole period. Tests in the open air indicate that the gauge needs a little time to attain a homogeneous temperature, but difficulties of this kind do not arise when the gauge is buried in soil where the temperature changes are small and occur very slowly. Since the wire and the gauge body are both of steel, errors due to temperature effects only occur when the gauge has been subjected to a recent temperature fluctuation.

Acknowledgments

The work described in this paper was carried out at the Road Research Laboratory of the Department of Scientific and Industrial Research as part of the programme of the Road Research Board. The paper is published by permission of the Director of Road Research.

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Exhibition of Industrial Power at Kelvin Hall

No. VI—(*Continued from page 859, June 29th*)

The Halls of Hydro-Electricity and Civil Engineering

The formation of the North of Scotland Hydro-Electric Board in the latter part of the last war has been responsible for considerable activity in the Highlands in the last five or six years, in the construction of hydro-electric schemes. It was, therefore, to be expected that the benefits of hydro-electric development would be prominently displayed in Glasgow's contribution to the Festival of Britain and, in fact, an impressive series of exhibits is on view, as indicated in our opening article on the Kelvin Hall Exhibition.

The display is largely concerned with murals and electrical appliances, and with various models, such as one of the Board's experimental wind generator and one of the Glen Affric national park. Many of the examples are taken from the Loch Sloy scheme, which has already been described in some detail in these pages.

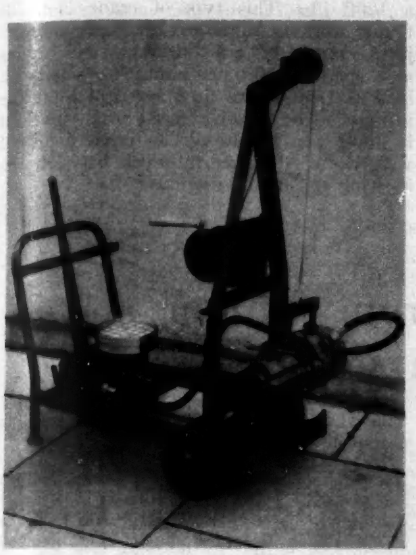
The display explaining the irrigation works on the Nile, which is to be found in the Hall of Civil Engineering, will also be of interest to hydraulic engineers. The Hall also has examples of public health engineering, bridge construction and public works plant. There is also a section devoted to prestressed concrete, which gives a good idea of the possibilities of that material and of the devices used for stressing and for anchorage.

The Freyssinet system of post-tensioned prestressed concrete is exemplified by a double-acting jack, anchorage cones and a prestressing cable. The corresponding devices of the Magnel system—sandwich plates, tensioning jack and cable—may also be seen. The various examples of pretensioning include models and full-size specimens of floor slabs, beams, stress beds, and wire grips and anchors. There is a hydraulic tensioning machine, an extractable rubber core, and a section through a stressed pile-head.

A more recent development in prestressed concrete and one which has been carried out in this country, is the Lee-McCall system of post-tensioning. This method employs high tensile steel bars, from ½in to 1¼in in diameter, in place of the more usual steel wires, the high tensile steel having substantially no creep at the high stresses employed. The 0·1 per cent proof stress of the bars is 54 tons per square inch and they are stressed to about 42 tons per square inch, leaving a permanent stress of 35 tons per square inch after losses due to

concrete shrinkage and creep have occurred.

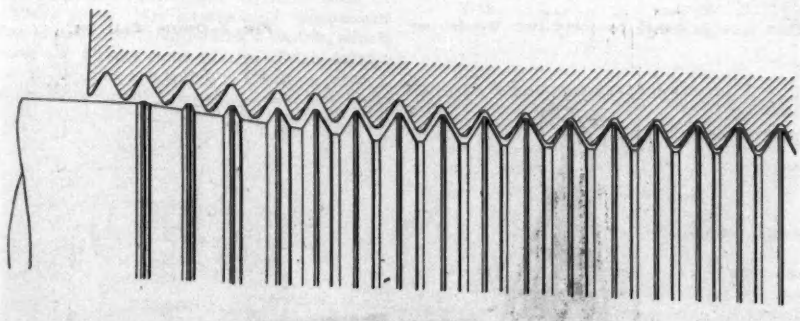
When the tensioning of a bar is carried out the legs of the hydraulic jack bear on a steel anchor plate, which is generally cast into the concrete; an adaptor is screwed on to the end of the bar and secured to the jack with a cotter. The force applied by the jack is measured on a pressure gauge



45-TON MOBILE PRESTRESSING JACK

or by the extension of the bar. When the full prestress has been applied, the bar is fixed by tightening the anchor nut until the gauge reading shows a drop of about 3 tons. Tightening can be continued beyond this stage but there is no need to do so. The accompanying illustration shows the mobile unit which has been developed for use with this system. The jacks and the pump are both mounted on the same trolley, together with a small winch for raising the jack to the level of the bar to be stressed; this arrangement facilitates tensioning the bars quickly.

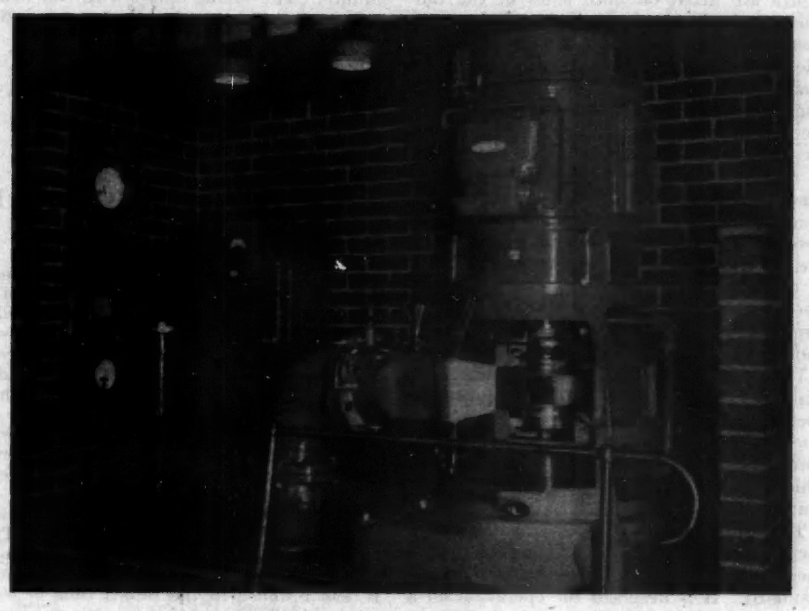
A new type of nut has been developed for use with this system, which is specially threaded, and when used in conjunction with a tapered end to the threading on the bars enables the nut and the threaded end



SECTION THROUGH HIGH EFFICIENCY NUT AND PRESTRESSING BAR

of the bar to develop the full strength of the unthreaded portion of the bar. Many tests have been made to demonstrate this property. The threading on the nut and the bar is of the form shown in the accompanying diagram, from which it will be seen that in the main part of the nut the threading of the bar is in full engagement with the threading of the nut. When the prestress is applied to the bar and the nut tightened in the normal way the whole of the working load on the bar is taken by this normal threading. However, when the stress in the bar is increased, say by overloading of the beam, the tapered, threaded portions of the nut and of the bar go into progressive engagement, thread by thread, as the tensile strain in the bar and the compressive strain in the nut increase. Since, in the final condition of ultimate stress of the bar, the last thread on the bar comes into engagement with the adjacent thread on the nut, and the bar is at this point of the full section, the ultimate strength of the unthreaded portion of the bar is fully obtained.

Because of the high strength of the alloy steel bars, these high efficiency nuts are correspondingly larger than normal and of special steel. Washers are provided to ensure approximately that the contacting face of the nut is closely adjacent to the finish of the tapered threading on the bar, but tests have shown that even when no particular care is taken to ensure this, the high efficiency nuts still develop substantially the full strength of the bar. It is, of course, not to be overlooked that the working stress in the bars does not normally exceed 0·6 of the ultimate strength and even loads on prestressed members slightly above the design load seldom increase the stress in the bar above that ratio. That there is evidently more than adequate end anchorage may be gauged from the fact that in all tests to destruction of beams, which have been carried out up to the present, it has not been possible to make an end anchorage fail. The Lee-McCall system, although using somewhat more weight of steel than the corresponding post-tension systems using wire, benefits considerably by the lower cost of bars compared with wire, and the great saving in labour. Since our first description of this system in our issue of April 21, 1950, it has been coming into increasing use both in this country and abroad; some contracts are already in hand in the United States, using steel and components exported from this country. As with other post-tension systems, it is being applied primarily to bridges and other work, where beams of moderate and long span are required; it is also suitable for prestressed concrete poles and piles, the development of which is now proceeding. Owing to the corrosion-resistant steel of substantial diameters and the robust end fixings, combined with the "crackless" concrete common to prestressed construction, this system is suitable for work where the highest degree of durability is required, for example in harbour works and deep foundations, as well as in bridges.



SINGLE STAGE CENTRIFUGAL PUMP

PUMPING PLANT

A notable feature of the exhibition is the impressive cascades of water in the Hall of Hydro-Electricity, which have necessitated the installation of a number of pumps. There is also an exhibit, which is illustrated herewith, showing the interior of a typical pumping station supplying water for industrial or public utility undertakings. It consists of pumping plant manufactured by the Harland Engineering Company, Ltd., with auxiliary equipment by Belmos, Ltd., Glenfield and Kennedy, Ltd., and George Kent, Ltd. The main exhibit, a Harland "Electroglide" single-stage, electrically-driven pump set, designed and supplied as an integral pump and motor unit for either vertical or horizontal operation, has a section of the pump casing cut away to expose the rotating impeller, the neck rings, bearings and shaft. It is a standard unit supplied for a wide range of duties and suitable for operation for twenty-four hours a day over long periods.

The fabricated casing is strengthened to support the motor and is designed to minimise radial thrust. It has axial suction

branches and its radial delivery branches facilitate positioning of the unit for the most convenient delivery line take-off. The end cover, which is made of fabricated steel, cast iron or bronze, according to the duty, contains the stuffing-box, neck-ring and sealing and balance connections.

The single-entry overhung impeller of cast bronze is balanced dynamically. A long shaft-mounting boss is extended through the stuffing-box and is fitted with a renewable stainless steel sleeve, where it passes through the pump gland. The impeller is "blind" at the suction end, thus eliminating contact between the liquid pumped and the driving shaft. Neck rings of leaded bronze are fitted on both sides of the impeller and the back neck-ring leakage is discharged to atmosphere or to the suction side of pump, so that the gland operates against low pressure. The gland packing rings are retained in a strong housing in the end cover and a lantern ring is provided for use where grease seal, clean water seal or internal seal is required. This gland is adequate for operation on a positive suction head and in certain circumstances it is possible to operate the pump without gland and packing. The pump shaft is an extension of the motor driving shaft of high tensile steel and it is machined to receive the impeller, which is secured by keyway, nut and impeller cap.

The motor is of Harland manufacture, built to B.S.S. No. 168 and designed to operate with the pump as a common unit. The end-cover, in the form of a circular flange, is bolted direct to the pump casing, which serves as a motor stool in vertical units.

The automatic air-break star-delta contactor starter is floor mounted in a sheet steel housing finished to waterworks standard. It is designed for operation on a supply of 400/440V, three-phase, 50 c/s, and is complete with a triple pole on/off isolating switch in a separate compartment.

The "Telerecorder" equipment includes a circular moving-coil milliameter receiving indicator. Provision is made for zero adjustment from outside the case and fluctuations in ambient temperature do not affect the accuracy of the indicator. The flow integrators are in a circular case and are continuous in operation and read directly in units of flow. Their movement consists of a high-grade watt-hour motor provided with heavy jewelled bearings, which are spring-cushioned to avoid damage by vibration. In the strip chart recorders the pen tracing is on separate widths of chart for each point. The chart drawing unit is a multiple slow-speed synchronous motor but an impulse motor or thirty-day spring motor can be supplied. The valve headstock is designed to allow manual operation of a 10in sluice valve inserted into the delivery pipeline.

Cranes and Excavators

Amongst the various models of constructional plant which may be seen in the Hall of Civil Engineering mention should be made of the model of the large walking dragline, which is at present nearing completion at the ironstone workings of Stewarts and Lloyds, Ltd., in Northamptonshire. The machine is the "Rapier W1400" of Ransomes and Rapier, Ltd., and is claimed to be the largest dragline in the world. It has a bucket of 20 cubic yards' capacity and a tubular steel boom 282ft in length and 175ft above ground level at the boom-head. The base of the machine is 48ft in diameter and its completed weight is 1500 tons; it is powered by two 1500 h.p. generator sets. The model on view at the Kelvin Hall is fully working and is about 7ft long, being to a scale of ¼in to 1ft.

The exhibits also include models of the plant made by Butters Brothers and Co., Ltd. There is a model on a shipyard monotower crane of 15 tons capacity with a jib 127ft 6in long. When used in shipbuilding yards the crane generally runs on rail tracks between the slipways, the gauge of track being approximately 25ft. The full load of 15 tons can be lifted at a radius of 90ft at a speed of 30ft per minute, or at a radius of 126ft at a speed of 100ft per minute. The luffing speed with full load is 40ft per minute and the slewing speed 300ft per minute. A fast auxiliary lift of 1½ tons capacity is also fitted, which operates at a speed from 100ft to 150ft per minute. The travelling speed with full load is 75ft per minute. The lattice tower is 16ft square and 76ft 6in in height above rail level. The crane is operated by five electric motors. Another model is of a 5 ton, two-motor electric derrick crane fitted with a 120ft jib. This type of crane is to be found working in a great variety of projects. It can lift a 5 ton load at 90ft radius at a speed of 50ft per minute or a two-ton load at 116ft radius at a speed of 120ft per minute. The slewing speed with full load is 400ft per minute. The crane is fitted with the single lever interlock between the hoisting and luffing motions.

(To be continued)

Large Clutch Drum Winder at Barnburgh Colliery

An extensive scheme of reorganisation and re-equipment at present in hand in one of the areas of the North-Eastern Division of the National Coal Board will cost some £4½ million to complete during the next two or three years. As part of this scheme, which embraces a number of mines, it was decided to wind all the coal up one instead of two shafts as hitherto at the Barnburgh Main Colliery. For this purpose there was installed a few months ago a new clutch drum winder of a kind on which the ropes can be adjusted to suit different seam levels in the shaft.

The new winder is one of three similar units built in the United States by the Hardie-Tynes Manufacturing Company for export to Russia, but afterwards allocated to European countries. It was installed in the record time of eleven months without interfering with production. To make this possible a new head gear (Fig. 1) was built at right angles to the existing gear and on it the two pulleys are arranged on the same centre line with one in advance of the other to suit the existing skip centres.

The new winding unit has a rope speed of 35·67ft per second, and winds to a depth of 2271ft. Its duty cycle is as follows:—

	Feet
Acceleration, 10 sec	178·35
Constant speed, 53·7 sec	1914·5
Retardation, 10 sec	178·35
Loading: 12 sec	
85·7 sec	2271

This is equivalent to forty-two winds per hour with 8 tons of coal per hour, that is, an output of 336 tons of coal per hour.

In the drawing we reproduce in Fig. 5 the general arrangement of the new winder can be seen. Its main drum shaft unit, which weighs 55 tons, is just over 40ft 6in long and is 3ft 2½in on its largest diameter. This shaft carries two 19ft 8in diameter rope drums, 7ft 11in wide on the barrel, and each is integral

Fig. 2—Drum Clutch

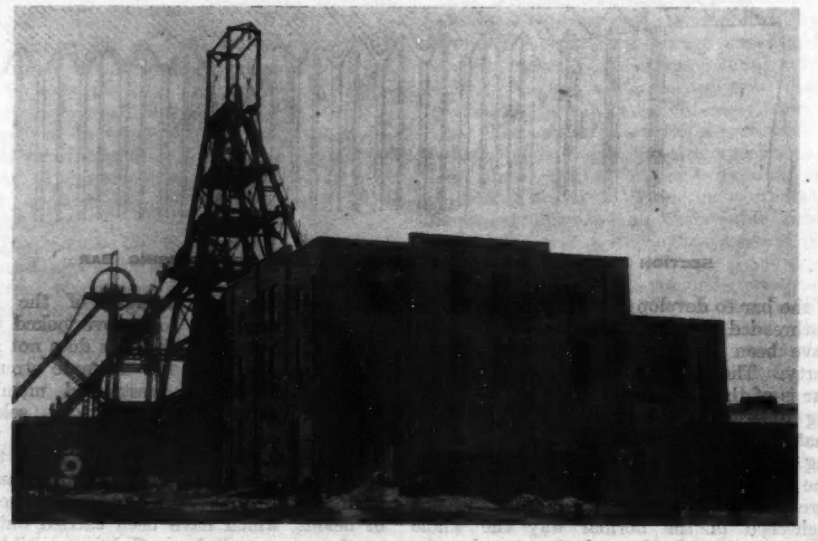


Fig. 1—Engine Room and Head Gear

with a brake ring 19ft 8in diameter and 2ft 2in wide. Each of these drums weighs 72 tons.

The main shaft, which is carried on three 32in by 48in bearings, is driven by two 1750 h.p., 350 r.p.m. motors through a double helical gear wheel, 13ft 6in diameter and 31in wide. One of the drums is keyed to the shaft whilst drive to the other, which runs freely on a bush, is transmitted through a multiple-toothed clutch. Parallel acting post brakes acting on each of the drums have brake beams 2ft wide, each weighing some 8 tons.

The brakes and the clutch are all hydraulically

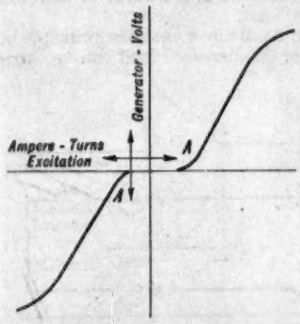


FIG. 3—NOMINAL CHARACTERISTICS OF CURRENT LIMIT GENERATOR

operated under a pressure of 150 lb per square inch at 25–30 gallons per minute from an accumulator and sump tank with duplicated motor-driven pumps. The brakes are of the loaded type and are applied by weights under gravity and released by oil under pressure through the hydraulic system.

The brakes are fitted with a number of renewable friction blocks. In normal operation and before any wear has taken place on the brake blocks, the brake-release piston moves through about 18in of its 24in stroke. As wear takes place the travel of the piston increases until the piston has to move about 22in at which time, unless the brake beams are adjusted the brake weight arm operates a limit switch to cut off the current supply to the motors. Further hoisting is then impossible until the brakes have been adjusted. When first fitted the brake blocks are 5in thick and they can be used until they are just under 3in thick.

The clutch is mounted by the loose drum at the end of the winder away from the main drive. As can be seen from one of our illustrations (Fig. 2), it consists of two arms mounted on the main drum shaft which have teeth at their outermost ends arranged to slide into engagement with an annular toothed ring bolted on the side of the drum. This clutch is operated by a 9in diameter, 24in stroke hydraulic ram similar to that fitted to the brake gear. An interlocking mechanism on the clutch gear incorporates a switch, which is open for all positions of the clutch except when it is fully engaged. There is also a mechanical interlock consisting of a cam lever

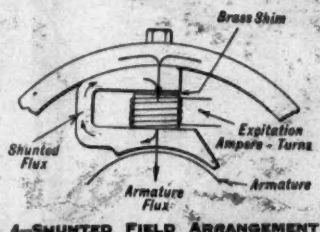
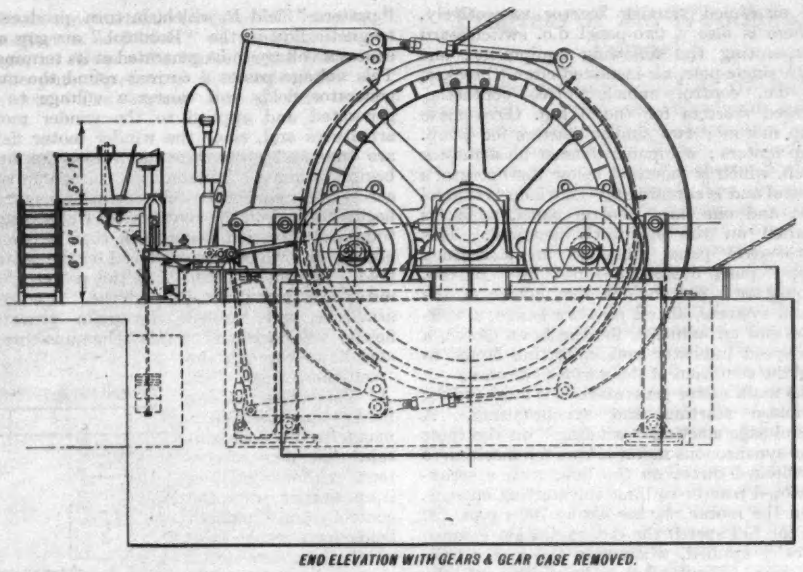


FIG. 4—SHUNTED FIELD ARRANGEMENT OF CURRENT LIMIT GENERATOR

which engages the brake hand lever in such a way that the clutch cannot be disengaged without stopping the hoist and fully applying the brake of the free drum.

Each of the winding drums is fitted with a Lilley safety controller and a gear-driven mechanical device designed to move the control lever automatically to the off position and apply the brake if the operator fails to slow down to the correct speed as the cage approaches the end of the trip. On each of these devices is a disc carrying adjustable cams which are set according to requirements. This disc is



END ELEVATION WITH GEARS & GEAR CASE REMOVED.

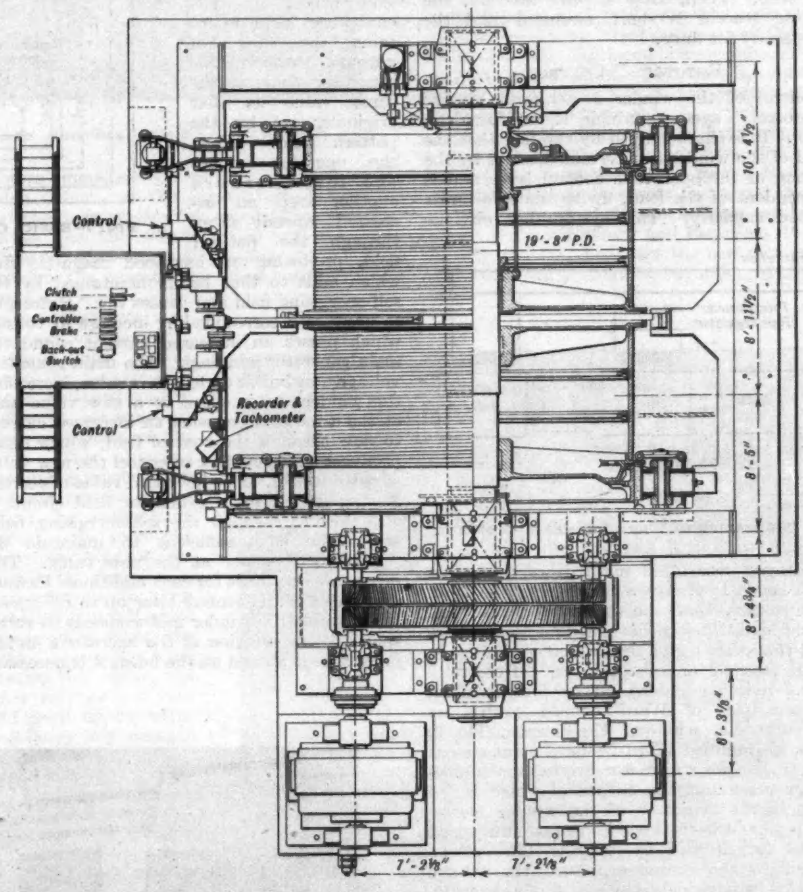


FIG. 5—GENERAL ARRANGEMENT OF WINDING MACHINE

stationary during the main part of the hoisting trip but, at the last 150ft of rope travel, it begins to rotate and during this period makes about a third of a rotation. As the disc rotates the cams, through counter-weighted operating arms, move the control and brake levers to control the final speed of hoisting. The cams operating the drum control levers are long and give a gradual slowing down movement, the brake drum cams are short and steep, and actuate the brake at the end of the trip if the operator fails to do so in time. The connections between the control device and the operating levers incorporate compression springs which allow for normal operation of the levers. But the cam follow up is very close and is only overcome in the event of an emergency when the operator can manipulate a lever in the opposite direction against the spring load.

ELECTRICAL PLANT

The winder is driven by two 1750 h.p., 600V compound-wound, d.c. motors, which take their supply from a motor generator set consisting of a 3500 h.p., 3kV synchronous motor direct coupled to two 1250kW compound-wound generators. There is an auxiliary motor generator set comprising one 100 h.p., three-phase, 380V motor driving a 40kW, 250V, constant-potential d.c. exciter. Control of the winder is achieved by a regulating "Rototrol" and a current-limiting "Rototrol," the operation of which is explained below.

The a.c. switchgear consists of a five-panel main switchboard made up of an incoming main switch, a motor-control switch, and a reactor switch, each of which is oil immersed and rated at 150MVA; the remaining panels accommodate the motor-control cubicle

and air-cooled starting reactor respectively.

There is also a two-panel d.c. switchboard incorporating the following equipment: one 8000A single-pole, air-insulated circuit breaker, one d.c. control cubicle; two contactor-operated starters for the 5 h.p. three-phase pump motors; two similar starters for ¾ h.p. pump motors; one potentiometer hoist master switch, which is mounted below the operator's pedestal and is actuated by the winder's control lever, and one hoist control panel, which is mounted on the operator's pedestal. This hoist-control panel embodies an emergency "stop" push button, a safe "off" button, "stop-start" buttons for the motors of the two oil systems, an oil pressure gauge, a voltmeter and an ammeter for the hoist motor, a rope speed indicator and indicating lamps to show the condition of the various switches.

The main motor generator set is arranged for automatic starting and synchronising. A squirrel-cage starting "winding" on the rotor of the synchronous motor allows the machine to be switched direct on the line, with a series-connected reactor to limit the starting current. When the motor reaches about 700 r.p.m. (90 per cent full speed) the d.c. excitation is automatically applied, whereupon the motor pulls into step. Then, after a brief interval, the starting reactor is short circuited and the set is ready for duty.

"Rototrol" Control

Control of the winder is achieved by the "Rototrol" system, which is of American origin. It is characterised by the fact that the speed of the winder is determined solely by the position of the operator's control lever and is independent of the load, up to the safe limits of load capacity. This system has obvious

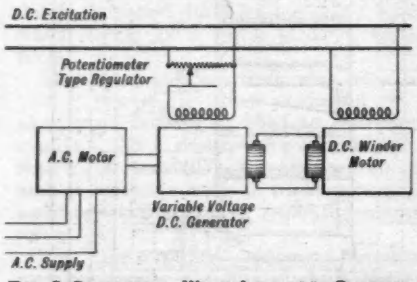


FIG. 6—SIMPLIFIED WARD-LEONARD CONTROL

advantages over other methods of control in which speed is always a function of the load, which means that the operator must "feel for his load" before he can determine where to set the lever to give the desired speed.

The method of operation of "Rototrol" control may be understood by first recalling the principles of Ward-Leonard control as applied to d.c. winders. The diagram (Fig. 6) shows a simplified Ward-Leonard arrangement consisting of an a.c. motor driving a variable-voltage generator, the output of which is fed direct to the armature of the winder motor. The motor field is kept constant and speed control is obtained by varying the voltage applied to the motor armature, the voltage variation being achieved by means of a potentiometer regulator in the generator field circuit.

An elaboration of this principle forms the basis of the "Rototrol" system in which a regulating "Rototrol" takes the place of the potentiometer regulator and varies the excitation applied to the main generator field system which, in turn, controls the voltage applied to the armature of the winder motor. The regulating "Rototrol" is a four-pole d.c. generator having five separate field windings uniformly distributed round the four poles; for the sake of clarity these five windings are shown diagrammatically in the illustration (Fig. 7). The function of the various field windings can be understood by considering what happens when the operator shifts his control lever.

On receiving the signal to start, the operator moves his control lever forward into the first position. This movement causes a small current to flow from the external source through the "pattern" field *B*, which, in turn, produces a magnetic flux in the "Rototrol" air-gap and causes a voltage to be generated at its terminals. This voltage passes a current round the main generator fields and causes a voltage to be generated and applied to the winder motor armatures and, since the winder motor fields are energised at a constant value, the hoist begins to move. As soon as a voltage appears across the main generator terminals a current begins to flow on the control field *C*, its magnitude and direction being such that it cancels out the flux which was produced by the pattern field. It will be noted that the pattern field initiated a current flow through the "Rototrol" armature and through the main generator fields; the diagram shows that the same current also flows through the "self-energising" field *A*. This self-energising field produces sufficient magnetic flux to maintain that flow of current without building it up, so that, when the control and pattern fields have reached the point where they cancel each other, the self-energising field maintains the flow of current through the generator fields at the same value as that originally set by the pattern field. When the operator moves the lever forward another step an increased current flows through the pattern field, producing an increased magnetic flux which adds to that being maintained by the self-energising field and causes the "Rototrol" to produce a corresponding increase in voltage which passes an increased current round the main generator windings. The main generator voltage now builds up to a new value, increasing the winder motor speed to a new value and, at the same time, causing an increased current to flow through the control field, which again produces sufficient flux to cancel the new value of pattern field. This increased value of current flowing in the main generator field circuit is also flowing through the self-energising field, and again it is sufficient to maintain the "Rototrol" output at the new value. This procedure continues for each additional forward movement of the control lever up to full speed.

To enable the winder motor speeds to correspond to the position of the operator's handle independent of load on the hoist, it is necessary to increase the voltage applied to the armatures when the load of the hoist increases. This can be done only by increasing the output of the regulating "Rototrol" when these extra loads come on. The "compensating" field winding *D* on the "Rototrol" is connected in parallel with the motor interpoles so that the current flowing in it is proportional to load; the flux produced thereby is in the same direction as the pattern field so that, during periods of heavy loads, it enables the pattern field to set up a proportionately bigger current output from the "Rototrol," this increasing the voltage output of the main generator to deal with this increased load.

It will be obvious that the principle of compensation for increased load can be carried too

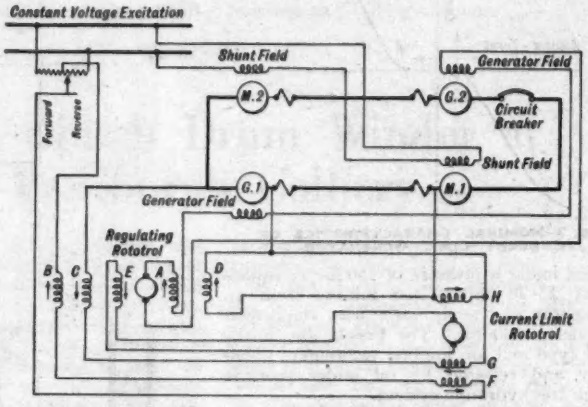


FIG. 7—BASIC CIRCUIT OF "ROTOTROL" HOIST CONTROL

far. If, for example, it was decided to fill the skip with dirt, the "Rototrol" would faithfully maintain the same speed characteristic as on light loads, at the risk of overloading everything connected with the plant, including the winding ropes. A current-limiting device is therefore included, which automatically limits the current through the winder motors to a value within the safe working range. This safeguard is achieved by employing a current-limit "Rototrol," as shown in the diagram.

This current-limit "Rototrol" is a d.c. generator having three field windings—a pattern field *F*, a control field *G*, and a current field *H*. It will be noted that there is no self-energising fields. Fields *F* and *G* are connected in series with the respective pattern and control fields of the regulating "Rototrol," so that they receive the same values of excitation and function exactly as explained for the regulating "Rototrol." The current field *H* is connected

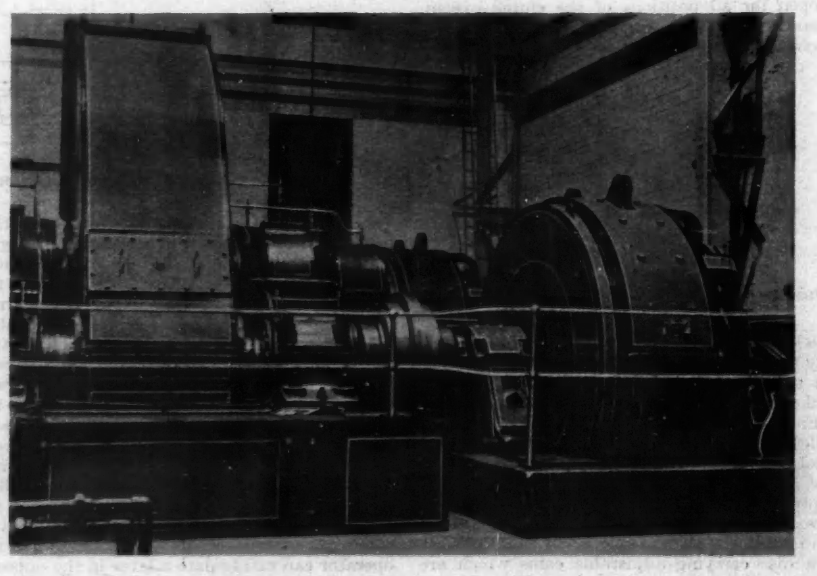


FIG. 8—DRIVING MOTORS AND GEAR

in parallel with the winder motor interpoles as is the compensating field of the regulating "Rototrol" so that it varies with the winder motor loads.

The current-limit field *E* on the regulating

FIG. 9—DRIVING PLATFORM AND CONTROL GEAR

"Rototrol" is connected across the output of the current-limit "Rototrol" in such a direction as to oppose the effect of the compensating winding. On being energised, the current-limit field neutralises any further increase in the value of the compensating field, thus restricting the output of the regulating "Rototrol," so that the winder motor current remains at the limiting value. The desired output characteristic of the current-limit generator is shown in Fig. 3, and its special shape is obtained by using a pole construction which incorporates a magnetic shunt as shown in Fig. 4.

The action can be best described by starting again from standstill and moving the control handle to the first position, which passes a current through the pattern field of the current-limit generator; now the flux produced instead of crossing the air gap as in the normal generator designs, follows a path around the magnetic shunt as indicated. Therefore, as no flux crosses the air gap, there will be no generator output, no current will flow in the current-limit field of the regulating "Rototrol," and there will be no current-limiting effect. Now as the hoist speed reaches a value corresponding to the first position of the controller handle, the control field becomes energised and neutralises the pattern field flux, which means that the magnetic shunt ceases to carry any flux. On moving the control lever to the next step an increased current again flows through the pattern field producing a flux which flows round the magnetic shunt and, as the hoist speed builds up to the new value, the control field builds up and again neutralises the flux produced by the pattern field. Therefore, it will be appreciated that the operative winding is the current field. As the load builds up from zero, this current field produces a flux which increases as the load increases. The flux passes round the magnetic shunt without crossing the air gap, so that no voltage is generated but, as the load increases towards the limiting value, the flux increases to such a value that it saturates the iron in the magnetic shunt. When this point is reached the shunt is unable to pass any more flux; accordingly, it crosses the air gap and from this point onwards the machine generates an output which increases with any further increase in load. Since the output of this current-limit generator is connected direct to the current-limiting field on the regulating "Rototrol," its effect is to neutralise that of the compensating field and so stabilise the output of the "Rototrol" and, hence, limit the current and torque in the main winder motors.

From the practical viewpoint of the operator the effect is as follows: on receiving a signal to go, he releases the brake at the same time as he puts the control lever into "full on" position. The current through the winder motors immediately reaches the current-limit value (which, in this installation, is 5500A), and the hoist attains full speed in ten seconds. Having put his lever to "full on" the value of the acceleration is independent of the human element, the operator can then wait until the automatic slow-down device takes over near the end of the wind, bringing the handle gradually to neutral, the motor speed quickly falling in response to each movement of the lever. This electrical braking is regenerative and is as rapid in action as in the acceleration period. To show the complete control obtained by the system it is possible to push the lever into full speed forward and, when the fully loaded hoist reaches full speed, the lever may be put into full speed reverse without doing any damage or overloading any part of the equipment.

The installation of the new winder involved an increase of more than 100 per cent in the colliery electricity load. To provide the new supply and to meet future requirements the Yorkshire Electricity Board installed a 66kV, 15,000kVA substation on the Goldthorpe Road, near Barnburgh Colliery. The substation was arranged so that it could be fed either from Mexborough or Ferrybridge power stations the supply being duplicated up to the colliery switchboard to ensure continuity of service.

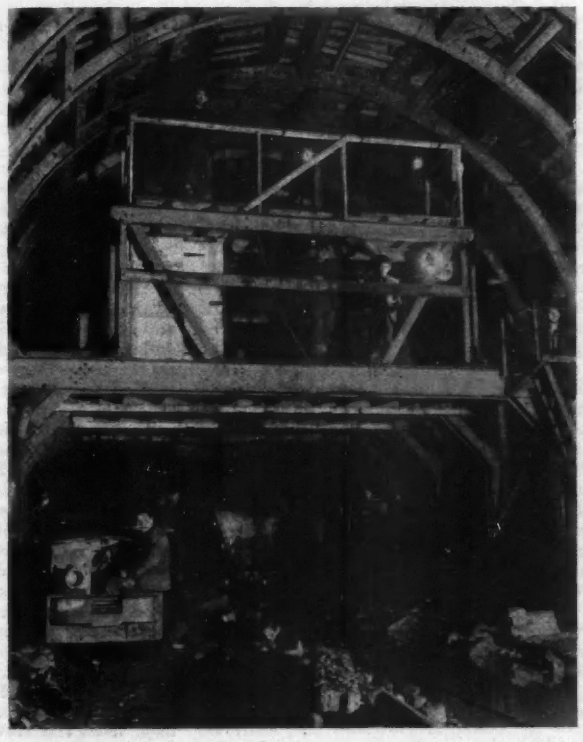
At the colliery switchboard the incoming supply feeds a 3300kVA bank of three single-phase transformers which are delta/star connected and are installed, together with a spare single-phase unit, on the engine-house site. These transformers step down the supply to 3kV for feeding the main a.c. switchboard.

Progress of the Woodhead Tunnel

WE were recently invited by the Railway Executive to visit the Woodhead tunnel, which is at present under construction in the Pennines from Dunford Bridge to Woodhead, and forms part of the Manchester-Sheffield-Wath electrification scheme. The tunnel will be concrete lined, with a maximum width of 27ft for up and down traffic. It is just over 3 miles in length with a central working and ventilation shaft 466ft deep. Work was started in the early part of 1949, and the pilot tunnel was holed through recently on May 1st. Enlargement to the full section is now in progress at each end of the tunnel. The work has included the construction of a water treatment plant to purify the water draining from the tunnel before it passes into the River Etherow, and a substantial cutting and a road bridge at the Dunford Bridge end.

The accompanying illustration shows the drilling gantry which is in use at the Dunford Bridge face. Mucking is done with three "Eimco 21" loaders working side by side. There is a second gantry behind the drilling gantry, which carries a hoist over each of the three tracks, and facilitates the shunting of the muck skips by lifting each skip off the track as it is loaded. The tunnel passes through shale and sandstone strata, and the excavation is supported by steel ribs in the weaker places, as shown in our illustration.

The general scheme for the new tunnel was prepared under the direction of the Civil Engineer of the Eastern Region, British Railways, and the detailed plans were made, and the conduct of the work at the site is being supervised, by Sir William Halcrow and Partners. Balfour Beatty and Co., Ltd., are the contractors. It was estimated that the construction of the new tunnel would take from three to four years, and it is planned to complete it in 1952. The total cost will be in the region of £2,800,000, which includes the laying of track and resignalling.



DRILLING GANTRY IN THE DUNFORD BRIDGE ENLARGEMENT

THE BRISTOL AEROPLANE COMPANY, Ltd., has elected to the board of the company Mr. A. E. Russell, its chief designer, aircraft division.

The British Instrument Industries Exhibition

No. I

MORE than 150 British manufacturers are taking part in the British Instrument Industries Exhibition which is being held at Olympia from July 4th to 14th from 11 a.m. to 8 p.m. daily, except Sundays. It is the first large-scale exhibition in this country to be devoted specifically to instruments and their application in science, medicine and industry. It shows clearly the extent to which progress in each of these fields of endeavour is associated with improvements in the art and practice of measurement—improvements not only in the design of instruments, but in their production on a commercial scale.

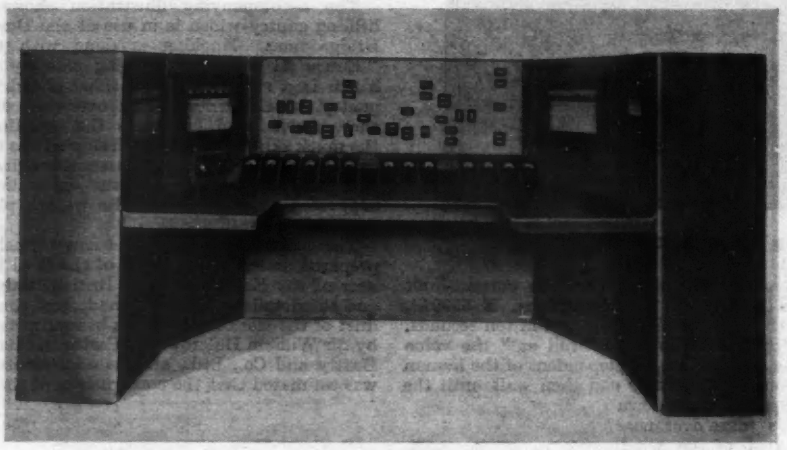


FIG. 1—"CENTROLLER" CONTROL CONSOLE—EVERSHED AND VIGNOLES

Nuclear physics, for example, has created a demand, extending beyond the research laboratory, for accurate and robust instruments to measure X-radiation. In surgery the study of the brain has been assisted by the development of an instrument capable of translating brain activity into electrical impulses and recording the resulting wave shape. In engineering and the manufacturing industries which are more immediately our concern, instruments are acquiring the status not of auxiliaries but of indispensable aids to production, thanks to the development of multiple gauging techniques. Electrical methods of measuring mechanical quantities such as strain, displacement and acceleration are firmly established and have extended the scope of experimental work in a variety of fields, including the design of structures, aircraft and guided missiles. Finally, the rapid development of servo-systems is finding profitable application in the automatic control of a multiplicity of processes ranging from fuel combustion to the manufacture of chemicals.

In the following paragraphs we describe a selection of the exhibits to be seen at Olympia, in an attempt to illustrate the scope of the British instrument industry and the services that it is capable of rendering to industry generally.

EVERSHED AND VIGNOLES, LTD.

An Evershed "Centroller" for the centralised operation of process plant forms the main exhibit shown by Evershed and Vignoles, Ltd., Acton Lane Works, Chiswick, London, W.4. The equipment is a self-contained unit (Fig. 1), consisting of a console on which are mounted the individual controllers and recorders for the efficient operation of the controlled plant. In this particular instance, the console is designed for use with a chemical process plant and houses a group of thirteen controllers—five for flow, six for liquid levels and two for pressures. In addition the console incorporates a control diagram, with twenty-five miniature edgewise indicators to show the levels and pressures in various columns and vessels, the flow in various pipes and the temperature in reboiler units.

Centralised control is achieved by the Evershed electronic system, which facilitates the remote indication and control of flows, levels, pressures and other quantities. Measurements of all such quantities are transmitted to the "Centroller" in the form of small direct currents which permit the use of multi-pen and repeat indicators. The various process controller assemblies are mounted on trays accommodated in racks behind the console face, and can be examined from the back of the "Centroller." To facilitate servicing of the equipment, the trays are coupled by multi-pin plugs, and may be withdrawn for inspection or replacement, all similar units being interchangeable.

Among the new pieces of apparatus to be seen on the same stand is an electronic process controller (Fig. 2), which is designed to give proportional or three term (that is proportional, integral and derivative) forms of control of any process.

The controller is operated in conjunction with one of the standard range of transmitters associated with the Evershed electronic repeater: throughout the system, which is current controlled, the signal is a small d.c. current having a maximum value of 30mA.

This signal, which is originated by a transmitter unit containing the measuring element, is passed to the controller via recording, indicating or integrating instruments. From the controller it is passed to the final control element, usually a control valve where the electrical signal is converted into a valve position by means of the Evershed electro-pneumatic relay. This relay embodies a mechanical feedback from the valve stem, ensuring that the valve position is truly proportional to the d.c. signal received. A typical control operation is illustrated in outline in the diagram (Fig. 3) which indicates the sequence whereby changes in liquid level in the left hand vessel are reproduced in the transmitter, passed on to the controller, which actuates a pneumatic valve, through the medium of an electro-pneumatic relay, and thereby restores the liquid level to the preset valve.

The controller, as illustrated, is provided with adjustments in the form of pointer knobs moving over calibrated scales under a hinged glazed cover, which is secured by two screws to render unauthorised access more difficult. Provision is made for transferring from automatic to hand control and the valve position is indicated by a miniature instrument in the front of the controller.

The controller is arranged for panel mounting and the case and terminal box are flame-proof, in accordance with B.S.S. 229/1946. With the exception of the mains lead, all circuits to the

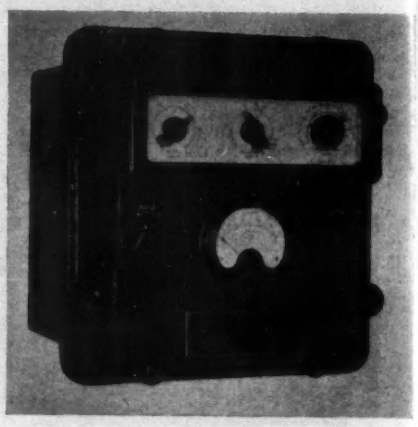


FIG. 2—PROCESS CONTROLLER—EVERSHED AND VIGNOLES

controller are intrinsically safe and the whole equipment may, therefore, be operated in dangerous atmospheres.

The operation of the equipment is independent of variations of supply voltage and frequency, or of the resistance of the signal lines. The components of the controller are mounted on trays fitted with multi-pin plugs, enabling them to be rapidly serviced by replacement, as all similar units of the equipment are interchangeable. All the adjustments to this controller are made by means of wire wound potentiometers and are thus accurately repeatable. The circuits of the various control functions are so designed as to be independent of each other. There is, therefore, no interaction

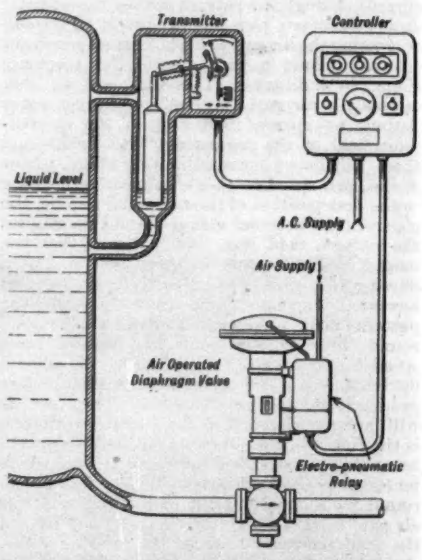


FIG. 3—LIQUID LEVEL CONTROLLER—EVERSHED AND VIGNOLES

of control functions during the operation of the controller and the adjustment of one form of control does not alter the value of any other.

Proportional control, in which the valve movement is proportional directly to the measured quantity, is achieved by repeating the signal received from the measuring element, by a photo-electric repeater which incorporates a differential shunt permitting adjustment of the proportional band. A unit whose output is a controllable datum signal in the form of a

small d.c. current is also provided, enabling the desired value to be set up in the repeater unit. The proportional band adjustment is calibrated 2 to 600 per cent.

Integral and derivative control are supplied by one valve whose anode current summates the integral and derivative terms. Integral control, in which the movement of the final controlled element is proportional to the integral of error with respect to time, is provided by a photo-electric bridge which detects the error and charges a large capacitor in the grid cathode circuit of the valve at a rate proportional to that error. The integral time control is calibrated from 2 to 50 minutes.

The derivative function, in which the movement of the valve is proportional to the rate of change of the measured quantity, is supplied by a static differentiating R-C circuit operated by the current in the measuring circuit. The output voltage of this circuit is added to that of the capacitor described above, in the grid cathode circuit of the valve. The derivative control is calibrated from 0 to 20 minutes derivative time.

Normally the final control function in the equipment described is exercised by an electro-pneumatic relay, which is designed to convert the output signal from the Evershed process controller into valve position. It receives a d.c. electrical input, and has an output in terms of air pressure which is converted into valve position by means of a mechanical feed-back. Referring to Fig. 4, the principle of operation is as follows. In the relay is a pivoted beam *A*, at one end of which is a coil operating in the field of a permanent magnet and through which passes the signal from the process controller. At the other end of the beam is a flapper operating in conjunction with the nozzle of a

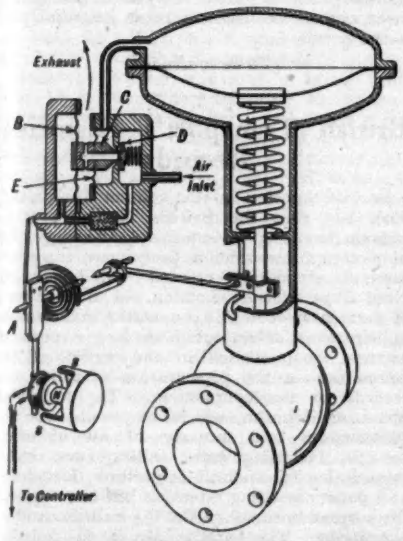


FIG. 4—ELECTRO-PNEUMATIC RELAY—EVERSHED AND VIGNOLES

low-bleed air relay, the output from which is fed to the diaphragm head of the valve under control.

The beam is attached to the inner end of an instrument type spring which exerts a turning moment about its pivots, while the other end of the spring is connected to an adjustable feed-back lever fitted to the valve stem. Movement of this lever therefore varies the torque exerted by the spring which is so arranged as to oppose that generated by the moving coil.

When the system is in balance, the spring torque is equal to that produced by the moving coil, which in turn is proportional to the controller output, and any change in this output will, therefore, unbalance the beam, causing a movement of the flapper with respect to the air relay nozzle.

This movement will vary the air flow through the nozzle, and hence the pressure on the primary diaphragm *B*, which will move, carrying with it the hollow plunger *C* operating in conjunction with the spring loaded valve *D*. Increase of pressure on *B* will connect the diaphragm head of the controlled valve to the air pressure inlet, and decrease in pressure will connect it to atmosphere.

The action continues until the force on the secondary diaphragm *E* equals that on the primary diaphragm *B*, when a state of balance is restored, at a new output pressure, and both *C* and *D* are closed.

Variation of pressure on the main diaphragm will move the valve stem, carrying with it the feed-back lever, and hence moving the outer

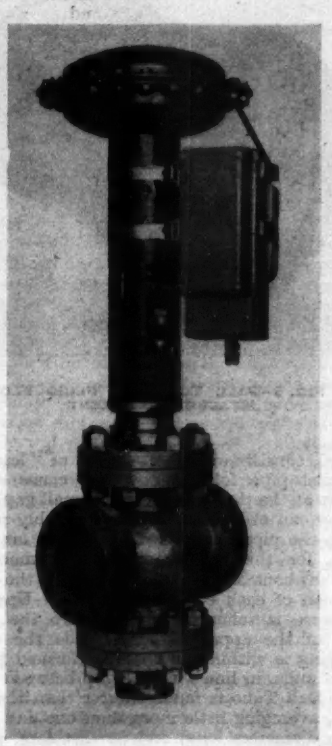


FIG. 5—ELECTRO-PNEUMATIC VALVE—EVERSHED AND VIGNOLES

end of the instrument type spring. This movement is in such a direction as to correct the unbalance between the spring and moving coil torques, and a state of balance is restored with the valve stem in a new position.

As movement of the valve stem bears a linear relationship to the spring torque operating on the beam, it will be seen that the valve position is directly proportional to the input signal, irrespective of air pressure and friction loading upon the valve. A typical arrangement of the relay in association with a pneumatically-operated valve is shown in Fig. 5.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD.

A temperature alarm relay, designed to initiate an aural or visual alarm when the temperature at a specified point exceeds a preset value, is displayed by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17. The instrument is specially applicable to the temperature of turbo-alternator rotor windings.

The principle of operation of the relay (Fig. 6) is that of balancing two forces, one of which depends on the rotor current, while the other depends on the rotor voltage. When the second of these forces exceeds the first, the relay contacts are closed and initiate an alarm which may be aural or visual or both. Operation of the relay, therefore, depends upon the quotient E/I, that is on R, the rotor resistance which is proportional to the temperature. A continuously variable rheostat provides the necessary adjustment and the scale is calibrated in degrees Centigrade, whereby the instrument can be set to operate at any desired temperature within its range.

As shown in Fig. 7, the current and voltage coils of the relay are wound on a horizontal cylindrical former suspended between the concentric poles of a permanent magnet. The spindle carrying the coil former is extended at both ends and is suspended on vertical leaf

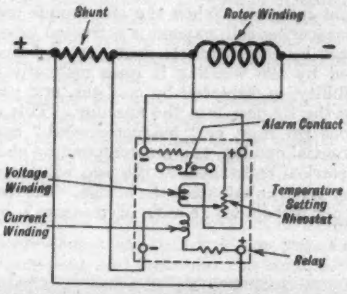


FIG. 6—CIRCUIT DIAGRAM OF TEMPERATURE ALARM RELAY—METROPOLITAN VICKERS

springs. The coil former also carries an insulated moving contact which closes to meet a fixed contact when the relay operates.

An adjustment range of 75 deg. Cent. can be supplied, the maximum and minimum settings being, for example, 75 and 150 deg. Cent. respectively. The current coil is designed for use with external shunts designed to give a volt drop of 300mV at rated current. The coil will

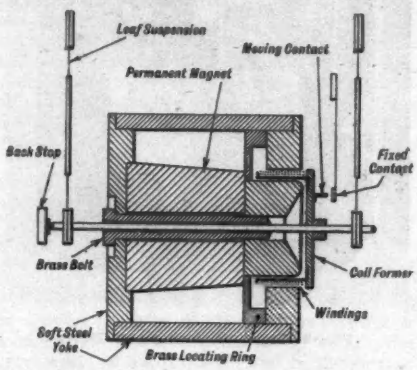


FIG. 7—TEMPERATURE ALARM RELAY MECHANISM—METROPOLITAN VICKERS

withstand 100 per cent overload current continuously and up to twenty times normal full load current for a short time. The voltage coil can be supplied for any voltage up to 500V d.c., and is conservatively rated so as to be capable of withstanding 40 per cent over-voltage continuously. A sheet steel case, measuring 7½in by 7½in by 6½in houses the relay, the external finish being semi-gloss stoved black enamel.

GEORGE KENT, LTD.

Among the instruments exhibited by George Kent, Ltd., Luton, is a new paramagnetic continuous oxygen recorder for use in industrial processes. Typical applications include the analysis of furnace atmospheres in the metallurgical industries, determination of the efficiency of the liquid-air process of oxygen manufacture, analysis of waste gases from open-hearth furnaces in the steel industry, assessment of the combustion efficiency of glass-melting furnaces, and analysis of flue gases in boiler plants.

The design of the primary element of the recorder (the analyser) is based on the so-called "magnetic wind" principle, making use of the fact that, of the common gases, only oxygen and nitric oxide are attracted by a magnetic field, oxygen more than twice as strongly as nitric oxide.

To obtain a continuous sample of the gas being analysed, a primary refractory filter is usually inserted at a suitable point in one of the gas passes. The sample is induced through the filter by a water-operated aspirator fitted to the oxygen analyser. The sample gases are carried through pipes to a measuring cell—an annulus

with a horizontal glass by-pass tube. This by-pass tube carries on the outside, two identical, adjacent platinum windings which are joined in a Wheatstone bridge circuit and become heated when a voltage is applied across the bridge. One of the windings only is traversed by an intense magnetic field from a large permanent magnet. When the gas sample enters the measuring cell, oxygen is attracted into the by-pass by the magnetic field. As it becomes heated by the winding it loses magnetic susceptibility, is displaced by cool gas, and passes along the by-pass into the annulus. This continuous gas flow, or "magnetic wind," causes differential cooling, and a corresponding change in electrical resistance, in the two windings on the by-pass, unbalancing the bridge. The resulting out-of-balance e.m.f. is measured by a

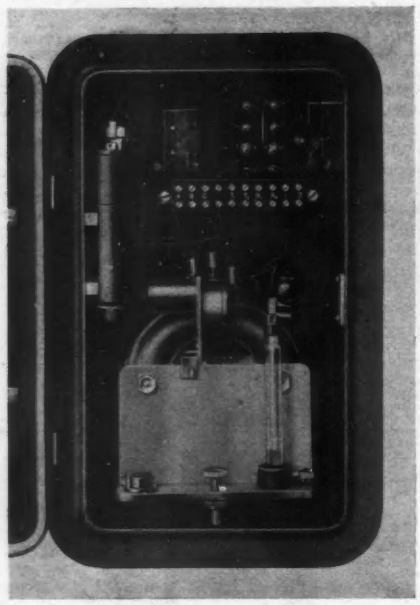


FIG. 8—OXYGEN ANALYSER—KENT

standard Kent "Multelec" potentiometer/recorder and is proportional to the oxygen content of the sample.

In operation a generous sample of 15 litres per hour is passed through the analyser, which begins to register a change of oxygen content within five seconds of its occurrence and gives a 95 per cent response in 45 seconds. An analyser of this kind is sensitive to ambient temperature conditions, which are automatically compensated by means of a resistance thermometer in a circuit capable of dealing with the range 0 to 50 deg. Cent. The temperature of the gas sample must not exceed 75 deg. Cent. at the analyser inlet.

The whole instrument is capable of dealing with most of the gas mixtures met with in industrial practice, but initially manufacture is being limited to the following ranges: oxygen in nitrogen, 0 to 5 per cent, 0 to 10 per cent, 0 to 15 per cent; oxygen in hydrogen, 0 to 2 per cent; oxygen in coal gas, 0 to 2 per cent.

The installation is mains-operated, and a constant voltage transformer is supplied with the equipment to smooth out supply voltage fluctuations. The primary element (the analyser) can be sited at any distance up to 400 yards from the recorder. As illustrated in Fig. 9, the analyser is mounted in a small cast aluminium case. All parts of the equipment in contact with the gas sample are made of corrosion resistant material.

Another new development displayed on the same stand is the Dall Tube, which is a device for producing a differential pressure for measuring fluid flow. For a given differential pressure, the Dall Tube is stated to be smaller and lighter than the "short" Venturi Tube, and to be superior to the "long" or "full" Venturi in differential pressure recovery. The manufacturers believe that these advantages have been secured without sacrificing accuracy since the discharge coefficient of the Dall Tube is stable and constant over the whole operating range.

A general view of the Dall Tube is reproduced in Fig. 9. The tube, which is made of cast iron or steel, with a liner of brass or gun-

FIG. 9—DALL TUBE FOR FLUID FLOW MEASUREMENT—KENT

metal, consists of a short length of "lead in" parallel pipe followed by two cones spaced apart at the throat, allowing a small gap. The larger end of both cones is appreciably smaller than the pipe bore. Both the cones are short and, for the smaller sizes, fully machined. Above about 24in pipe diameter, only the centre portion of each cone is machined. Upstream pressure is taken out just before the larger end of the approach cone, while the throat tapping is within the chamber formed by the cone walls, in line with the gap between them. The Dall Tube is much shorter than the Venturi, averaging little more than one and a half pipe diameters long, and is, therefore, correspondingly lighter and can be made as a complete unit.

The Dall Tube can be used as a differential amplifier in combination with a large Venturi Tube (say upwards of 30in). A small by-pass carrying the Dall Tube is fitted between upstream and throat tappings on the Venturi. The greatly amplified head generated by the Dall Tube is led to a second measuring instrument (the first being across the main tube), enabling readings to be taken down to about 1/20th or 1/30th of the maximum flow in the Venturi. In this way the combination gives a wide flow range with low head loss.

The Dall Tube may be installed at any angle. For water flow measurement the tappings should be at the side of horizontal or sloping mains. The equipment should be installed with at least ten pipe diameters of straight length on the upstream side. No straight length of pipe is required downstream, and any form of control required should be fitted on this side.

GENERAL ELECTRIC COMPANY, LTD.

A new equipment for measuring mechanical quantities electrically and for indicating the results at a distance, developed by Salford Electrical Instruments, Ltd., is one of the interesting instruments to be seen on the stand of the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. This new electro-mechanical converter system has a wide range of industrial applications, including the measurement of gas, liquid and steam pressures, liquid levels, compression or tension in structural members and pressures in rolling mills or presses; likewise the system can be used for load indication on cranes, &c., positional indication (e.g., valve indication at remote point), temperature measurement, and direct measurements of length up to 0·1in (Fig. 10). Operation is from a.c. mains and the indications can be transmitted directly over several miles.

The basic principle of the system is that of a change of inductance in a circuit and the inherent difficulties of earlier change-of-inductance systems, due to magnetic leakage temperature errors, and poor electro-mechanical efficiency, have been overcome by the use of a new magnetic powder material, "Gecalloy PL." The powder is moulded and used as the magnetic circuit of an electro-mechanical transducer, which can be regarded as an electrical transformer, with a core that is moved by the originating mechanical force. The primary winding of the transformer is connected

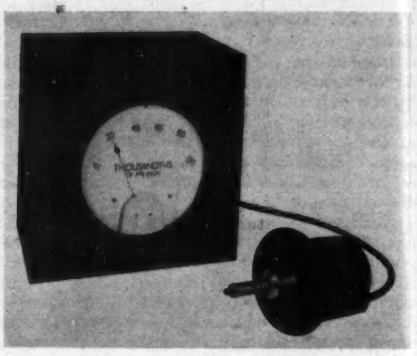


FIG. 10—ELECTRO-MECHANICAL CONVERT —G.E.C

to a.c. mains through a step-down transformer, and the secondary winding is connected to a special dynamometer type indicator, which gives a reading corresponding to the originating movement. The electrical system is, in effect, a method of measuring mutual inductance of the converter in which the instrument movement and electromagnet are an essential part of the circuit.

(To be continued)

British Transport's Historical Records

IT was reported in this column on January 26th last that the British Transport Commission had accepted in principle the suggestion of a committee that a permanent transport museum should be created and housed in Nine Elms Station, London. A further step of some interest in this connection is the recent appointment of an archivist and a curator, as was recommended in the report of the committee on the preservation of relics and records to the commission. The archivist, Mr. L. C. Johnson, will be responsible for the preservation and custody of all historical records, including early railway and canal minute books, and all important documents and papers meriting retention but not required for current business of the Commission and its executives. The curator, Mr. J. H. Scholes, will be responsible for organising the custody and display of old prints, pictures, models, rolling stock, typographical specimens and other relics illustrating the history of public transport by road, rail and inland waterways. One of his tasks will be the establishment of a London collection of relics as recommended in the report. Mr. Johnson will have an office at 66, Porchester Road, Paddington, W.2, and Mr. Scholes will have his office at Euston Station.

"H.P.88" Jet Research Aircraft

IT was recently announced by Handley Page, Ltd., that a new prototype research aircraft, the "H.P.88," designed in collaboration with, and constructed by, Blackburn and General Aircraft, Ltd., at Brough, has successfully completed its first test flight. This aircraft has an experimental Handley Page wing, and is powered by a Rolls-Royce "Nene" turbo-jet engine. No further description is permitted.

B.S.R.A. Resistance Experiments on the "Lucy Ashton"*

By Sir Maurice E. Denny, Bt., K.B.E., S.B.†

The purpose of this first paper is to give a general review of the scope of the full-scale resistance experiments carried out on the former Clyde paddle steamer "Lucy Ashton," by the British Shipbuilding Research Association, and to state the underlying aims and objects of the work. The paper deals primarily with the full-scale research carried out on the ship and some of the results are given in view of their interest and importance, and in order to demonstrate the quality and accuracy of the experimental observations.

A surface vessel in steady motion through the water experiences resistance due to the following causes :—skin friction ; wave-making and energy losses due to the formation of eddies.

Measurements of the hull resistance of the "Lucy Ashton" over a wide range of speed were attempted with the fundamental aim of securing information for the comparison of ship resistance with the resistance predicted from model tests.

Accurate values of ship resistance over a wide speed range enable extremely valuable comparisons to be drawn between these resistances and the corresponding values of resistance deduced from model tests. Such comparisons would clarify the relative merits of the various methods for calculating the skin friction correction between model and ship.

There are also possibilities in ship resistance tests of assessing the effect of fairing seams and butts, different ship surfaces, paint deterioration, of determining the resistance of such appendages as twin-screw bossings, "A" brackets with shafts, and of obtaining virtual inertia factors from acceleration and retardation tests, &c. With this in mind a programme of full-scale research was prepared as follows :—

Resistance tests over a range of speeds from 5 to 15 knots in the following conditions :

Clean naked hull having a red oxide paint surface and sharp seams (the shell plates had flush butts) : repeat with a bituminous aluminium paint surface ; clean hull with red oxide paint surface and dummy twin-screw bossings ; clean hull with red oxide paint surface and dummy twin-screw "A" brackets and shafts ; clean naked hull having a red oxide surface and seams faired off with a plastic composition ; repeat previous test with a bituminous aluminium paint surface ; naked hull with bituminous aluminium paint surface which has been allowed to foul for about one month ; and acceleration and retardation tests to be carried out as opportunity offered.

In conjunction with this, comparable tests are being carried out on a series of geometrically similar models in an experiment tank. There will be six model sizes in all, ranging in length from 9ft to 30ft.

When it had been decided to attempt ship resistance measurements, various methods of carrying out the tests were considered in great detail, and propulsion by means of aircraft jet engines was chosen.

Considerable alterations were made to the hull. The outer surface of the shell plating (which had flush butts, with internal straps), was carefully cleaned and found to be very rough and pitted in various localities. The shell surface was therefore made as smooth as possible by means of fairing material and the plate edges were sharpened so as to be, as far as possible, in the condition prevailing in a new vessel. It should be noted that due to the combined effects of age and application of fairing material, the plating was practically smooth so far as rivet points were concerned, since few, if any, of these protruded from the finished surface.

The vessel had no astern power, and to overcome this defect, and to assist in stopping the ship in an emergency, two large steel hinged flaps were fitted, one port and one starboard, underneath the engine gantry. These are normally stowed in a horizontal position clear of the water, but can be dropped to the vertical position to act as water brakes. Trials have shown that by using the brakes the ship can be pulled up from a speed of 11 knots to 2 knots in about four-and-a-half ship-lengths.

The principal dimensions and particulars of the vessel are as follows :—

Length between perpendiculars	190ft 6in
Breadth moulded	21ft 0in
Depth moulded	7ft 2in

Most of the experiments were made at a mean draught of 5ft 4in (measured over the 4in deep bar keel) corresponding to a displacement in salt water of 390 tons at level trim. The coefficients of form in this condition were as follows:—

Block coefficient	0·685
Prismatic coefficient	0·705
Midship area coefficient	0·972

The wetted surface area in this condition, including rudder and bar keel, was 4488 square feet.

Accurate measurement of thrust was of vital importance in this project and Macklow-Smith hydraulic load-measuring capsules were chosen as being the most suitable for this application. The capsule consists essentially of a shallow cylinder and piston enclosing a small quantity of hydraulic fluid with a pressure connection led to a remote reading pressure gauge fitted on the instrument panel in the engine control room. Instead of a gland between the piston and cylinder, however, the seal is made by an annulus of rubber bonded to the walls of the cylinder and piston. When load is applied to the outer face of the piston the pressure on the enclosed fluid rises accordingly, and the rise is registered on the pressure gauge and is a measure of the applied force. The displacement of the piston under the maximum applied thrust is extremely small—less than a hundredth of an inch—with the result that the resistance set up by the rubber bonding is negligible and in any case is accounted for in the calibration of the device. The effect of the rubber-bonded seal, therefore, is to produce what is equivalent to a "frictionless" piston and cylinder and overcomes any doubt or difficulties that might arise due to friction or sticking in a conventional packed gland or lapped ram. This type of capsule is very robust and accommodating in that tests have shown that its operation is not adversely affected if the application of the load is not strictly axial, which was an important consideration in this ship-borne installation. The pressure connection between the capsule and the pressure gauge was made with a flexible hydraulic tube of $\frac{1}{16}$in bore. Each engine was fitted with its own thrust-measuring device on these lines.

Instrumentation for the Trials

The ship's speed was obtained by sighting mile-posts situated on shore, but in addition to the usual visual sighting by observers with stop-watches, a "photo-finish" device was used. This instrument is known as a "cine-theodolite" and is essentially a theodolite with a moving film camera attachment which takes a permanent film record of the observations, and its use enabled the ship speed with respect to the land to be determined with a very high degree of accuracy.

A special mast was fitted on the ship to take the wind-measuring instruments, which consisted of a carefully balanced wind vane and cup anemometer. Both the mast-head anemometer and the wind vane had electrical transmission to indicating dials fitted on a recording panel situated in the wheelhouse. To ensure against electrical breakdown, wind speed was also measured by an observer with a hand-anemometer.

A continuous record of rudder angles was taken during the mile runs, and both visual and automatic recording was adopted. With regard to the latter an electrical transmitter was attached to the rudder head, which recorded rudder movement on a dial on the instrument panel in the wheelhouse. Direct visual observations of rudder angles were also made by means of a pointer attached to the quadrant in conjunction with a large graduated scale of degrees which could be easily read through the windows of the wheelhouse.

An automatic observer was fitted in the wheelhouse, which consisted of a panel of instruments which was photographed every ten seconds during the mile runs by means of a moving film camera. This panel included the remote reading dials for wind speed, wind direction and rudder angles, and in addition a small magnetic compass and a centre-second clock were also fitted.

To explore the velocity distribution in the boundary layer, two Pitometer logs were fitted in the ship's bottom close to the middle line, one 72ft 6in and the other 97ft 4in from the forward perpendicular.

Measurement of Hull Surface Roughness

As previously mentioned, it was found that after scraping and cleaning, the steel bottom was pitted to some extent and quite rough to the touch. Bearing in mind the importance of surface roughness on skin frictional resistance, the bottom was carefully treated and prepared in order to make it comparable with that of the freshly painted plates of a new steel ship.

In the first place, two thin layers of "filler" or rivet cement were applied to the bottom with an interval of several days between the applications. Two coats of ordinary red oxide paint were then applied, which was to be the basic surface throughout the trials. This treatment produced quite a good surface which was considered comparable to, but not superior to, that of a freshly painted new ship.

The strakes of shell plating were $\frac{1}{4}$in thick and the edges were sharpened somewhat to make the seams comparable with similar seams on a new ship. The butts of the plates were fitted with inside straps and were flush on the outside.

In view of the known inportance of surface roughness it was decided as far as possible to make roughness measurements on the hull before each trial. Two types of gauge were used to measure the roughness, both of which have been developed by the Metrology Division of the National Physical Laboratory, Teddington.

The wall roughness gauge consists essentially of a steel probe of 0·125in radius and has a working traverse of approximately 12in. The movements of the probe normal to the surface under examination are recorded autographically on a paper strip at a vertical magnification of 10. The horizontal traverse is full size. This instrument is most useful for recording local unfairness in the plating or long period "waviness." Due to the relatively large size of the ball probe, however, it is not suitable for recording short period roughness or quality of paint surface. For records of this nature the aerofoil gauge was used. In this case the probe has a radius of $\frac{1}{32}$in, and its vertical movement is magnified 18 times and transmitted to a scribing point which makes a record on a smoked glass plate. The maximum traverse of the probe is 6in, but this is reduced six times on the trace recorded on the smoked glass plate. Subsequent optical enlargement of the record is made to facilitate the analysis.

In the course of the trials it became known that bituminous aluminium paint would probably give a smoother surface than the ordinary red-oxide paint generally used in these trials. Sample plates were therefore prepared and tested in the Talysurf machine, which showed an improvement of the surface finish of the order of 40 per cent in favour of the aluminium paint. It was then decided to add to the programme a series of tests in which the hull was treated with this paint to ascertain whether it had any beneficial effects on the resistance. The preliminary comparative results of these trials are discussed briefly in a later section of the paper.

When treated with this aluminium paint the hull surface appeared to be smoother and harder than the red-oxide paint and this was borne out by roughness records taken with the aerofoil gauge. It was noted that the average values of the measured roughness for freshly painted red-oxide and aluminium paint were 0·009in and 0·006in respectively. Little comparative

* International Conference of Naval Architects and Marine Engineers, 1951, London, June 26th. Abstract.

† Chairman, William Denny and Brothers, Ltd. Chairman, Research Board, B.S.R.A.

information exists on the roughness of the hulls of new vessels, but it is interesting to note that Dr. Kempf quotes a figure of 0·012in for freshly painted ships.

Conduct of the Trials

It was decided to run the trials on the measured course in the Gareloch, which has almost all of the desirable features for trials of this kind, including absence of strong tides, reasonably good shelter from winds, and adequate depth of water.

It was originally intended to run these trials only under ideal weather conditions, but it was occasionally necessary to run in natural winds of speeds up to about 10 knots.

Many factors had to be considered before deciding upon the number of runs, the thrusts and their appropriate engine settings, &c. Thrust gauges were calibrated before and after each day's running, the automatic observer instruments and cine-theodolite equipment were checked and watches synchronised and tested. Immediately before and after trials the draughts were read, readings of water temperature and density were obtained and samples of water were occasionally taken from which the viscosity of the water was determined.

Double runs were made over the measured course and the following observations taken :—

Time at start of mile ; time over half-mile and mile by stop-watches and cine-theodolite ; wind speed by hand anemometer and electric anemometer ; wind direction ; the helm angle recorded to a base of time. The Pitometer log was lowered and read at the end of the mile run, but before altering course for the turn, in order to check the water speed for tidal analysis ; the required engine thrust settings were made during the approach to the mile and no further throttle adjustments were made until the mile was completed. Photographic records were taken of the instruments on the automatic observer panel ; visual records were taken of the sea surface conditions ; the amount of fuel consumed during each run was determined ; and change of trim during the mile runs was noted.

The times on the mile were taken at the half-mile as well as the full mile posts. This was taken as a precaution to ensure that the vessel was fully up to speed when running over the mile. To ascertain the minimum length of run necessary in approaching the mile, acceleration trials were carried out and the results of one of these in which the ship was accelerated from rest up to a speed of 13·7 knots shows that a steady speed was reached in about ¾ mile. In the acceleration trial referred to, distance run and speed were measured by means of a floating log or drogue.

Results Obtained

Analysis of all the data obtained during the trials is a lengthy process, and for this reason it is not possible to present complete resistance results at this stage. Moreover, the corresponding model experiments to complete the ship-model comparison are not yet available.

It is desirable to assess the accuracy possible in these experiments.

Speed can be measured to a considerable degree of accuracy and at 10 knots the error is of the order of one-tenth of 1 per cent. To determine the speed through the water necessitates correction for tide, and it is not a simple matter to resolve the separate effects of wind and tide.

Thrusts delivered by the jet engines were measured to an accuracy of approximately ±5 lb for each engine. At low speeds of about 5 knots, where only two engines are used, this error would amount to about 1½ per cent on resistance, and at top speeds of about 14½ knots where four engines are used it would amount to about one-sixth of 1 per cent.

Rudder angles were negligibly small.

The most difficult correction is that for the effect of wind. Attempts were made to measure the wind resistance of the hull when moored to a buoy in natural winds of various velocities. In the wire securing the vessel to the buoy a Macklow-Smith capsule was fitted, and the gauge readings showed considerable fluctuations, as is to be expected in natural winds. From an analysis of the many readings obtained in this way it was possible to arrive at a fairly reliable figure for the resistance due to a wind blowing from directly ahead. With relative winds at various angles to the vessel's centre line, the correction is not determinable from measurements on the ship, and to obtain further and more accurate information on this point a special model was constructed and tested in a duplex wind tunnel. With this combination of full-scale and model results, the wind and air resistance of the hull can be computed over a wide range of wind directions from dead ahead to dead astern. The accuracy of the corrections for the effect of wind and air resistance is a little difficult to estimate, but the maximum error involved is not more than about 1 per cent of the ship resistance over the whole speed range.

All the records have not been reduced and analysed, but resistance curves for the four naked hull conditions are presented and discussed. These are as follows :—

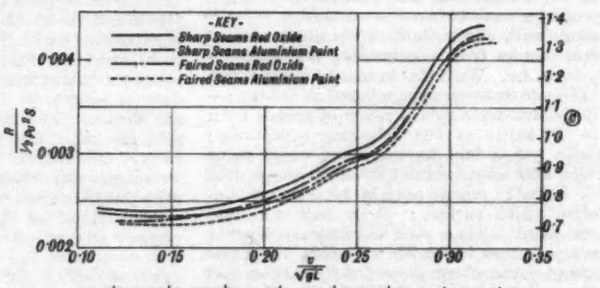
Sharp seams with red-oxide paint ; sharp seams with bituminous aluminium paint ; faired seams with red-oxide paint ; faired seams with bituminous aluminium paint.

The experimental observations for the two sharp seam conditions are plotted ; once in the form of pounds resistance against speed in knots and again in the non-dimensional form $R/\frac{1}{2}\rho V^2 S$ against Froude number $V/\sqrt{gL}$ and Reynolds number VL/ν, S being the wetted surface of the hull, the other symbols having the usual significance. Scales of **C**, speed in knots and $V/\sqrt{L}$ are also given.

The estimated wind and air resistance has been deducted from the experimental observations and they have been corrected to a standard temperature of 59 deg. Fah. and a mean displacement of 390 tons.

To facilitate comparison between the results for the different conditions the four resistance curves have been brought together in the accompanying diagram in the non-dimensional form of presentation.

Comparing the curves for the sharp seam conditions it will be noted that the smoother aluminium paint surface has slightly less resistance, on the average about 3·5 per cent less than the red-oxide paint. On the basis of the estimated skin friction resistance, which is perhaps the better criterion for this effect, the average difference amounts to about 5 per cent.



Naked Hull Resistance Curves

Referring now to the results for the two faired seam conditions it will be noted that the smoother aluminium paint surface has again slightly less resistance, on the average about 3 per cent less than the red-oxide surface. This is of the same order as the improvement of 3·5 per cent obtained in applying aluminium paint to the sharp seams red-oxide condition.

Comparing the next sharp seams red-oxide curve with that for the faired seams red-oxide, it will be noted that the seam fairing has reduced the resistance slightly and on the average the reduction amounts to about 3 per cent. The fairing consisted of a wedge of composition 3in wide, i.e., twelve times the thickness of the overlapped plating which was ¼in. It has to be mentioned here that when the ship was docked for inspection after this trial it was found that about 25 per cent of the seam filler was missing and the gaps were fairly evenly distributed throughout the length of the ship. There was no evidence to suggest when the missing filler came away, but assuming the very worst circumstances, i.e., that only 75 per cent of the filler was intact when the trial began, then by simple proportion it seems not unreasonable to suggest that the complete filler might have improved the resistance by 4 per cent at the most. As it is more likely that the missing filler came away late in the trial rather than early, the former figure of 3 per cent is probably the more correct.

The improvement due to seam fairing can also be independently assessed by comparing the curves for sharp seams with aluminium paint and faired seams with aluminium paint. On the average, the latter is about 2·5 per cent less than the former, which is of the same order as the reduction obtained when the seams were faired in the red-oxide paint condition and appears to confirm the lower figure of 3 per cent referred to in the previous paragraph.

It is clear from the above, therefore, that the effect of fairing the seams taken by itself is to reduce the total resistance by about 3 per cent and the separate effect of the application of the smoother aluminium paint is to reduce the total resistance by about the same amount.

The combined effect of fairing the seams and applying the smoother aluminium paint is given by direct comparison of the curves for sharp seams with red-oxide and faired seams with aluminium paint and on the average the overall improvement amounts to about 6 per cent.

In the non-dimensional presentation it will be seen that, apart from some local deviations, there is a general distinct parallelism between the various curves. This will tend to diminish the percentage difference between the curves at high speeds due to the rising resistance coefficient $R/\frac{1}{2}\rho V^2 S$ or **C**. In the above discussion only the mean percentage differences over the whole speed range have been quoted.

Also of interest are the results obtained with a deteriorated aluminium paint surface due to the ship having been laid up at the buoy for a period of forty days. Before slipping the ship in preparation for the next trial condition, the opportunity was taken to make a few runs on the mile, and the increase in resistance due to the bottom deterioration was found to be of the order of 3·5 per cent on the total resistance. On the basis of skin friction resistance this increase is of the order of 5 per cent. On slipping the ship it was found that there was no visible evidence of fouling apart from the fact that the hull was covered with a light scum, which was slimy to the touch. There was also appreciable exfoliation of the top coat of aluminium paint which was ascribed to the paint having been applied in frosty weather.

Another interesting point was to investigate the comparative performance of the two outer and two inner engines to ascertain whether the impingement of the jet stream on the water some distance aft of the stern had any effect on the performance of the ship. With this in mind, some runs were made with outer engines alone and then the inner engines alone working at the same thrust, and the measured speeds were very nearly the same.

Thickness and velocity gradient of the boundary layer were recorded at two positions in the forward half length under the flat of bottom by means of the Pitometer logs.

Conclusions

(i) It has been shown that the direct measurement of the full-scale resistance of the "Lucy Ashton" has been achieved with a high degree of accuracy over the speed range of 5 to 15 knots.

(ii) For the measurement of full-scale ship resistance the trials have shown that propulsion by means of aircraft jet engines is eminently suitable in that :—

(*a*) The delivered thrust and therefore the resistance can be very accurately measured.

(*b*) The ship can be handled and manœuvred on the measured mile with the same facility as any other vessel with conventional means of propulsion.

(iii) In the light of the above it is considered that this method of carrying out full-scale trials overcomes difficulties in resistance and speed measurement inherent in towing, which has been the method adopted by previous experimenters in this field.

(iv) The trials have emphasised the importance of the effect of the condition of the hull surface on the resistance. In this connection, and using the resistance of the clean-naked hull with sharp seams and red-oxide paint as the basis of comparison, the preliminary results have shown that :—

(*a*) Fairing the seams reduced the total resistance by about 3 per cent.

(*b*) When the hull was painted with bituminous aluminium paint the total resistance was reduced by about 3·5 per cent, which is equivalent to about 5 per cent on the estimated skin frictional resistance.

(c) When the seams were faired and the hull painted with bituminous aluminium paint the total resistance was reduced by about 6 per cent.

The improvement in resistance with the aluminium paint surface has been borne out by roughness measurements, which have shown this surface to be smoother than that of the red-oxide paint.

(v) Trials run with the naked hull with a bituminous aluminium paint surface after the ship had been laid up for forty days showed that the total resistance had increased by about 3·5 per cent. On the basis of estimated skin frictional resistance this amounts to about 5 per cent. Subsequent docking showed that there was no evidence of fouling apart from a thin coat of slime, and the increase in resistance was to be ascribed to this and to the deterioration of the paint surface.

(vi) The results give definite proof of the sensitivity of full-scale ship resistance to small roughnesses and emphasise the importance of obtaining the smoothest possible surface on the finished ship.

The Royal Ordnance Factory, Blackburn

The Royal Ordnance Factory at Blackburn, Lancs, is principally concerned with the production of mechanical time fuses as fitted in anti-aircraft shells. The production of this unit compares in many respects with that obtaining in the horological industry, and during our brief tour of this establishment we noticed that many of the machine tools were of Swiss origin. The general design of the factory was suggested by Swiss practice, which aims to admit the maximum amount of daylight upon the more delicate operations.

It was realised that there was a serious lack of capacity for this kind of production in Great Britain prior to the last war, and consequently work on this new factory was commenced as early as 1938. A more formidable task was that of providing personnel trained for this specialised work. By 1942, however, a predominantly female labour force of 5500 working on a double shift were employed, recruited mainly from the cotton industry in the immediate neighbourhood of the factory.

The mechanical time fuse in this country is stated to have been developed from an early German fuse used towards the end of the first World War. Its later development and production for the Armed Forces was attempted by several British instrument makers, and the design underwent continual modification until in 1939, production of a series of marks known as the "Fuze 207" was commenced at Blackburn. With the rapid increase in operational speeds and heights of military aircraft it became necessary to replace this series with the "Fuze 208," the type now in production.

The nose assembly has four distinct components, the magazine, body, dome and cap, which are placed in that order upon the shell. Within the body is mounted the clock mechanism, the finger of which is spring-loaded against and registers with the base of the dome unit. The dome is adjustably mounted and in its base is a hole shaped precisely to the profile of the clock finger. In operation the finger is retained whilst bearing against the base of the dome, until with time, it rotates into alignment with the recess, this period being determined by the angular "lead" given to the recess when presetting the dome. On firing the shell, a centrifugal trigger is thrown due to its rotation and the clock mechanism set in motion. The finger being spring loaded rises when having attained alignment in the dome and releases the striker. If the shell is fired without being set it would normally explode as if set to zero height. This disaster is avoided by a device which ensures that the finger has to make almost a complete revolution before passing through the gap in the dome base. A further precaution against static explosion of the shell is a shutter which, until centrifugally loaded, seals the gas passages to the magazine. The clockwork mechanism is housed within and between three circular train plates, and includes a main spring and centre wheel, intermediate wheels, escapement and hair spring.

Production

Within the main shop are housed batteries of Swiss 10mm and 4mm clock-making automatics by Jos. Petermann, S.A. Moutier, Switzerland. Another Swiss machine, the "Rotomatic" 4mm machine, has also been installed which, having rotating cutters, is able to be coil fed. This machine, however, is not suitable for threading purposes. The smallest thread used in the clock mechanism is a No. 12 B.A. There are also several 10mm British Wickman automatics of the latest design. A number of four-spindle B.S.A. machines, and of Wickman five-spindle chucking automatics are used to form the body and dome.

Statistical control methods are extensively employed, particularly with production, on the clock-making automatics. It was estimated that "out of control" production in the worst cases is less than fifteen minutes, by which time an irregularity is traced, and the machine receives its "caution" disc. Inspection of this work is largely carried out with Sigma comparators and shadowgraphs.

There are a considerable number of repassing machines mostly by the Essa Press Company. When producing wheel blanks and other discs these machines feed the die through whilst, at the same time, causing it to vibrate in the same plane. The resulting chipping and shearing motion helps to eliminate tearing and burring on the bottom surface of the blank. Some of the very small pinion holes (about 0·004in diameter) in the train plates are similarly obtained. Drilling elsewhere in the body is assisted by the use of jigs and gates.

For teeth cutting purposes the blank wheel discs of the clock mechanism are formed in a cylindrical block and placed in multi-head milling machines. The escapement wheel itself has a complex tooth profile and is worked in a machine fitted with five milling spindles. During the assembly of the mechanism the components associated with each plate are fitted separately at their respective benches, are later placed together, and the mechanism finally tested.

Amongst equipment of interest in the tool room was a Hauser jig boring machine. It has a pneumatic drilling head with speeds up to 45,000 r.p.m., and uses a diamond-impregnated pin with which holes of the order of 0·032in are made. Aural equipment is fitted in order to detect contact of the pin and the work.

Endurance Test of Turbo-Propeller Engine

The production version of the Rolls-Royce 1400 h.p. "Dart" propeller-turbine engine has just completed successfully a 500-hour endurance test at Derby.

The test schedule simulated as far as was possible the conditions likely to be encountered by "Viscount" aircraft during routine service.

One typical portion of the test simulated engine requirements during the Rome/London stage of a return flight from Athens. Details of this part of the test are as follows :—

Taxi-out	6 min	6,000	r.p.m.
Take-off	1 min	14,500	r.p.m.
Climb	42 min	13,300	r.p.m.
Cruise	2 hr 11 min	13,300	r.p.m.
Descent	25 min	10,000	r.p.m.
Approach and landing	5 min	10,750	r.p.m.
Taxi-in	6 min	6,000	r.p.m.

The engine speeds used were those recommended by Rolls-Royce for route operation. Since the test was carried out at sea level this has resulted in much higher powers being developed than would be the case at altitude, so that the test may be regarded as being more arduous than the normal operation.

During the taxi-out and take-off periods the engine was subjected to an artificial sand-storm, with sand at the rate of 0·03 gramme per cubic foot of air being injected. This amounted to over 1 lb per minute at take-off and during the 500 hours test nearly 2 cwt of sand passed through the engine. During the climb periods the oil temperature was maintained at the maximum permissible of 90 deg. Cent, for flights at which high oil temperatures are likely to be experienced. For thirty minutes of each cruise period the de-icing system was switched on and for a portion of each flight water was sprayed on to the engine to simulate a heavy rainstorm at the rate of 50 gallons per hour whilst taxi-ing and at 150 gallons per hour during take-off. In addition, during one representative flight in every 100 hours, the engine was operated with the period at take-off power increased from one to five minutes and with climb and cruise carried out at the maximum continuous power condition.

With the exception of the flight exhaust unit, which was undergoing development, no parts of the engine were replaced during the test. The combustion equipment, including the flame tubes, the burners, and the air casing, had previously run for 240 hours, so that these parts have completed a total of 740 hours.

Throughout the test only scheduled maintenance and inspections were carried out and these occupied a total of 46·6 man-hours or 0·092 man-hours per engine hour.

One engine of the same kind has successfully passed three civil type tests consecutively, namely, a British Type Test, then a Civil Type Test to the schedule recently proposed by the U.S. authorities, followed by a repeat British Type Test.

Rolls-Royce "Dart" engines have now completed 9500 hours on the test-bed at Derby and, in addition, 5000 hours of flight testing has been completed without a single feathering.

Fuel Policy Co-ordinating Committee

In a speech at the annual conference of the National Union of Mineworkers last Tuesday, the Minister of Fuel and Power, Mr. Noel-Baker, announced that a special committee was to be set up immediately to investigate the wider aspects of national fuel policy. The appointment of such a committee, he said, had been urged by the Federation of British Industries and the T.U.C. and it would be supplementary to the Fuel Efficiency Committee.

The Minister indicated that among the matters which the new committee would consider were whether the various forms of fuel and power were being used to the best advantage; whether electricity should be used for domestic and industrial heating; whether gas should be used for public lighting, and what were the true costs, including capital costs, of fuels at present used for various purposes.

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RAW MATERIALS AND CONTROLS

At the recent banquet in celebration of the Golden Jubilee of the British Standards Institution, Mr. Gaitskell referred to the manufacturing capacity of the free world "out-running" the supply of raw materials. Professor Zuckerman has also given expression to the same thought. In an address to the Parliamentary and Scientific Committee he even went so far as to suggest that in a world whose population is rapidly growing and whose peoples are demanding higher living standards, demand is likely "chronically" to outstrip supply. Others think like them. They take the scarcities of certain raw materials that developed soon after the outbreak of war in Korea and more particularly after the Western nations had decided to rearm, as a sign of the existence not only of a temporary shortage consequent upon a suddenly increased demand, but of a phenomenon likely to persist indefinitely into the future. We confess we do not understand them.

Certainly the present shortages are real enough. One of their consequences for this country has been the creation of a new Ministry, with Mr. Stokes in charge, to look after the supply of scarce materials. Another has been the decision to bring into operation an interim scheme for the allocation of steel, zinc, copper and other materials until such time as a system of full control, possibly as complete as that ruling during the war can become effective. But we find it difficult to believe that there is any reason why the stringency should necessarily persist once the abnormal demand created by rearmament has subsided. Nor can we appreciate what is meant by such a statement as that demand is likely "chronically" to outstrip supply—or rather in what way such a situation is considered to differ from that which normally rules in times of peace. For, short of the actual exhaustion of deposits, raw materials have always been available, at a price, in sufficient quantity to meet demands save only when demand has suddenly been driven upward by some emergency; and they always will be available, providing only that the using industry is prepared to pay an economic price settled by the productive capacity, the demand, the costs of production and what economists call the "elasticity" of the market. What Mr. Gaitskell and Professor Zuckerman mean, therefore, can only be that the costs of raw materials in the future are likely to prove higher than usual in relation to the prices that finished products will fetch. But is there any ground for that belief? For cannot the relationship be soon returned to a more normal balance by the diversion of more capital and more machinery to the development of raw materials production? Indeed, if supply and demand are left free to do their beneficient work unhindered by controls and restrictions that adjustment is automatic. For the increase in raw materials prices that follows upon increased demand necessarily encourages the venturesome either to bring into operation materials production plants or processes that had been uneconomic at the lower price; or to find and develop substitutes that may well turn out to be not merely temporary "make-do" substances but, properly used, alternatives as satisfactory for their purposes as the originals. Nor is there anything abnormal in using alternatives. The job of the industrialist, aided by the engineer, is not only to make a satisfactory article. It must be made so economically that it can be sold. Cost, that is, enters into design and designs and manufacturing methods must be altered as prices of materials, labour, power, capital, &c., change.

But if it is impossible to visualise how any increase of industrial productive capacity over raw materials supply could persist for long in a free economy, it is undoubtedly possible for that condition to persist in a "controlled" one! Indeed, we appear to have an example of that state in our own British home economy. The raw materials of industry are not only minerals and similar substances. Power and transport must be included amongst them. In an address to the British Electricity Conference, reported in our last issue, Lord Citrine, Chairman of the British Electricity Authority, criticised the Government for its decision to limit investment in generating plant. "If our investment programme is still further curtailed, industry, commerce and the public generally must realise that there may be a shortage of electricity, particularly in severe weather, for a decade." In short, the stringency in the supply of electricity is being brought about by Government decree! Again, industry is being hampered in its attempts to increase output and decrease costs by the refusal of the Government to permit sufficient expenditure upon the improvement of the roads and the railways. Therefore, when we see such happenings at home and when we hear Ministers talking of a persistent, world-wide shortage of raw materials, we are driven to wonder whether the development of the world's resources is not similarly being hampered abroad by Governmental refusals to permit capital expenditure upon raw materials production plants. In fact, if, in a year or two's time, when the immediate and suddenly increased demand due to rearmament is over, Ministers still tell us that the raising of our industrial output is being delayed by shortages of raw materials, we shall take leave to differ. For our part we shall confidently lay the blame where it will truly belong, on faulty planning and improperly contrived controls.

AGRICULTURAL ENGINEERING PROGRESS

The Show which is organised every year by the Royal Agricultural Society of England is an event which has many a time been called a review of British farming progress. The many thousands who visit it may see the best examples of the cattle and poultry which are raised in this country; they may see the processes and products of modern dairying, and they can witness demonstrations of truly rural crafts such as farriery, thatching and hurdle making. There is always a forestry exhibit which emphasises the value of British timber, and an exhibit showing corn and root crops in growth and methods of weed and pest control. These are some of the components of every Royal Show which enable farming progress to be assessed. But such an assessment can never be made to-day without full consideration of the vast array of machinery and implements which forms so large a part of the Show. This part of the Royal Show cannot fail to impress upon even the most casual visitor the great influence of engineers over this country's biggest rural industry. The Royal Show now not only reviews farming progress; it reviews also the progress of agricultural engineering.

This year's "Royal," which is being held at Cambridge this week, has already proved to be a meeting place for engineers as well as for farmers. To accommodate it, a site of no less than 150 acres has had to be prepared, and almost half that area is needed for the display of the machines and other equipment which are essential to modern

farming practice. This is the fourth occasion since the Royal Agricultural Society was founded that the Show has been held in the university town—or city, as it has now become—of Cambridge. The first time was as long ago as 1840, when, about the three dozen implements displayed, the comment was passed that "the attention of some makers had been directed more to novelty and ingenuity of design than to skill in execution"—a charge which could certainly not be brought against British agricultural engineers to-day. By the time the "Royal" went to Cambridge again, in 1894, we were suggesting in these columns that portable, semi-portable and traction steam engines "had reached finality," and that the centre of agricultural engineering interest was the "unsavoury oil engine." Certainly, for many years, steam power influenced the development of agricultural machinery design, but much more striking changes have occurred since the power of the internal combustion engine has been applied to the cultivation of the land. The first World War, with its heavy demands upon the farms of this country, led to the general acceptance of the agricultural tractor as a desirable item of farm equipment, and, by 1922, when the Show was last held at Cambridge, the machinery exhibits demonstrated the growth of the tractor population and also the development of tractor-drawn implements. In those days, however, the tractor was looked upon principally as an economical substitute for the draught horse, once the initial expenditure had been accomplished. Its power to pull implements was appreciated, but its possibilities for driving the moving parts of those implements had been by no means fully considered. In the years which have followed, years which have included the heavier demands of a second world war and its succeeding food shortages, engineers have encouraged farmers to understand how the internal combustion engine has revolutionised the agricultural industry, bringing to it a tireless source of energy not hitherto available. The Cambridge Show this week, displaying a greater range of tractor-mounted, power-driven implements than ever, brings home that point.

But such achievements as are again so well demonstrated by this year's Royal Show have not been reached without unflagging effort on the part of engineers. Their products, which are available to the farmers of to-day, show ingenuity, and yet simplicity, of design, and show also that "skill in execution" which the British engineering industry maintains. For those products there continue the demand of an extensive home market, and, what is equally important, a growing export demand. The makers of agricultural machinery in this country are not at all likely to lag behind in design and even in greater standardisation. But they are likely, we fear, to experience, like many other sections of the engineering industry, the difficulties created by the current shortages of many essential raw materials. It is to be hoped that those shortages may be no more than temporary. Meanwhile, the task of agricultural engineers will be less onerous if, in the allocation of scarce materials, it is fully appreciated that mechanised agriculture is an important corollary to the defence programme.

Obituary

SIR EDWARD MacCOLL

THE engineering profession will have learned with deep regret of the death of Sir Albert Edward MacColl, which occurred in Edinburgh, following a heart attack, on June 15th. He was the Chief Executive Officer and Deputy Chairman of the North of Scotland Hydro-Electric Board; an office which he had filled with distinction since the formation of the Board eight years ago.

Sir Edward was born in Dumbarton in 1882 and was educated at Dumbarton Academy, the Royal Technical College, Glasgow, and Glasgow University. His practical experience in electrical engineering was gained in the Clydebank shipyard of John Brown and Co., Ltd., where he served for five years. For some time thereafter, Sir Edward was engaged on the development of Glasgow's municipal tramway system and, then, in 1920, he took up an appointment as executive engineer and assistant to the general manager of the Clyde Valley Electrical Power Company. Seven years later, on the formation of the Central Electricity Board, Sir Edward became the first regional manager and was responsible for the grid undertakings in Scotland. The planning and development of hydro-electric works in the North of Scotland led to the constitution of the North of Scotland Hydro-Electric Board. Sir Edward, as Chief Executive Officer, successfully supervised the design and construction of the Board's various schemes, many of which have been described in our columns.

Sir Edward, whose knighthood was conferred in the Birthday Honours of 1949, had been a member of the Institution of Electrical Engineers since 1912. He was a Past-Chairman of the Institution's Scottish Centre.

Literature

Bergwerksmaschinen. By DR. H. HOFFMAN. Berlin: Springer-Verlag, Reichpietschufer 20, Berlin, N.35. Price Dmk. 36.

THIS book is a comprehensive review of mining machinery and deals with its construction and operation. It covers a wide field and is presented in a way suitable for the working operator or student with an education of a standard equal to the National Certificate of this country. No quite similar book has been published in Britain and its translation into English would supply a want felt by many mining students. The early chapters deal with the general principles of thermodynamics and the laws governing the flow of fluids. Considerable space is given to formula relating to friction of air and water in pipes.

A section is devoted to fuel and its combustion, and comparisons are made of the value of the various fuels, solid, liquid and gaseous. The construction and operating of steam boilers is very fully dealt with. This section is particularly interesting as the generation of steam at high pressures received earlier and fuller attention in Germany than elsewhere. Mechanical stokers and the use of pulverised fuel are illustrated. The chapter dealing with the application of steam to the reciprocating engine differs little in content from the typical text-book in English. The development of the steam turbine is traced from its early stages and examples of various designs are very fully described and illustrated. Succeeding chapters deal with condensing water cooling, the application of steam for heating purposes, and heat storage. The internal combustion engine, four and two-stroke, is well treated. Diesel engines are fully described and comparisons made with the Otto cycle engine.

Of special interest at the moment to British mining engineers is the section on winding. Winding by drums, spiral and parallel and also by the Koepe system, is fully discussed. The multiple rope method for winding from deep shafts is explained. Skip winding is described in detail. Among the illustrations of wire ropes it is interesting to note one kind, the flat rope, known in Britain only as a relic. Equally interesting is the absence of the locked coil rope, which has become popular in this country.

The pumping sections contain nothing to indicate that pumping practice in Germany is in any way ahead of that of Britain. Much space is devoted to compressed air generation by piston and turbo-compressors, transmission and application. Multi-stage compressors with inter-stage cooling are described in detail. Mechanical, isothermal and overall efficiencies are examined. Compressed air picks and hammers, which have been popular in German mines, are dealt with and various examples are described and illustrated.

Longwall machine mining has not attained the importance in Germany that it has in Britain, but recent development of what is commonly known as the "Plough," and newer forms of scraper conveyors with system of roof support, are dealt with.

As was to be expected in the section dealing with underground locomotives, first place is given to those driven by compressed air. These locomotives have never won any popularity in this country. Germany was the pioneer in the application of the diesel locomotive for underground transport and detailed drawings and descriptions are given. British mining engineers might have wished for more information on trolley electric locomotives, a system widely used in Germany and now receiving much consideration at home.

The section dealing with ventilation calls for little notice. In this sphere of mining operations German practice is no more than on a level with this country. The portion devoted to refrigerating machinery may be of interest to those faced with the mining of coal at greater depths.

The closing chapter on measuring technique is valuable. We may have been somewhat slow in adopting the instruments and methods available but this is a matter that must receive greater attention in the future.

Generally this is a useful and valuable book and, as indicated, a translation or a book on very similar lines would be a welcome addition to British mining literature. The illustrations throughout are clear and detailed.

Basic Refractories—Their Chemistry and Technology. By J. R. RAIT. London: Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 60s.

FOR various reasons there is a dearth of authoritative books on the subject of refractories. This fact makes Dr. Rait's book doubly welcome. The main emphasis is on the constitution of the commonly used basic refractories, its determination and its relevance in the improvement of these refractories and their performance in steel-making practice. The sequence of chapters is commendable, the first few covering raw materials, their composition and processing, and a useful review

of the literature providing the existing thermal equilibrium data. From this review it was possible to ascertain, in general terms, the extent of the information still required to enable the author to attempt the computation of the constitution of these refractories. The two chapters that follow are occupied with an account of the author's experimental work and calculations to establish the data outstanding. This involved an investigation of the following systems: (1) $CaO—MgO—Fe_2O_3$; (2) $MgO—Al_2O_3—Fe_2O_3$; (3) $MgO—SiO_2—Fe_2O_3$. Parts of (4) $CaO—MgO—SiO_2—Fe_2O_3$; (5) $CaO—MgO—SiO_2—Al_2O_3$; (6) $CaO—MgO—Al_2O_3—Fe_2O_3$; (7) $MgO—SiO_2—Al_2O_3—Fe_2O_3$; and (8) part of the system $CaO—MgO—SiO_2—Al_2O_3—Fe_2O_3$ in which MgO occurs as one of the phases. The distribution of the various phases was also studied, taking into account the limitations of the X-ray method of phase determination, e.g., the difference between the number observed and the calculated phases. The last chapter but one is devoted to the occurrence and formation of liquids in these refractories under firing and operating conditions and is a fitting introduction to the final chapter, in which the author focuses attention on the ultimate aim of the whole study, which is to establish the mechanism of destruction of these refractories under various conditions and consequently indicate the way to improve quality and performance.

There are a number of criticisms which could be levelled at the book, but they are, on the whole, of a minor character: some are textual. For example, the key to the photometer curves on page 81 is not used in Fig. 27, although it is used in subsequent curves. The first curve marked MgO in this figure seems to be that of CaO; it would also have been better to use formulæ instead of mineral names, e.g., monticellite. The simple description of the heating and cooling of a composition in the system CaO—MgO (pages 41–42), if necessary after referring to standard text-books on equilibrium diagrams (page 38), should have been more precisely worded. Incidentally "d" in text is α (alpha) on diagram.

Not everyone will agree with all the author's conclusions concerning the performance of basic refractories. A sufficient number of collated investigations of steel melting furnace samples and their corresponding operating conditions, to give statistical significance, would have added more weight to some conclusions. The main substance of the book is a thesis, which may explain the departure from the usual text-book style and the absence of a wider treatment of some of the subjects covered. The title of the book is broad and could have included basic refractories in the non-ferrous industry. However, it would have been a help to those less well informed if the author had risked a definition of basic refractories. The book is nicely printed and on good paper but the binding is poor.

BOOKS RECEIVED

Turret Lathe Setters' Pocket Book. By J. A. Oates. London: George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 6s.

Cams and Springs for Poppet Valves. By W. H. Lee. Manchester: Emmott and Co., Ltd., 31, King Street West, 3. Price 2s. 6d.

Physical Mechanics. By Robert Bruce Lindsay. Second edition. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 37s. 6d.

The Slide Rule in Theory and Practice. By G. P. Rawlings. London: Percival Marshall and Co., Ltd., 23, Great Queen Street, W.C.2. Price 9s. 6d.

Plastics Moulding Engineering. By M. Freund, London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 45s.

The Royal Show at Cambridge

No. II—(*Continued from page 869, June 29th*)

THE Royal Agricultural Society's annual show, which this year is being held at Cambridge, opened on Tuesday last, July 3rd, and ends to-day, July 6th. This is the fourth occasion during the 112 years of the Royal Agricultural Society's existence that its show—or "country meeting," as it used to be called—has taken place at Cambridge, the last occasion being in 1922 when, in five days of wet weather, 92,352 people paid for admission.

As mentioned in our last issue, the show this year has been assembled on a site of approximately 150 acres at Trumpington. The "Grand Ring" is about 200 yards long and 100 yards wide, or almost as large as the whole of the space occupied by the first Royal Show to be held in Cambridge in 1840. Work on the preparation of the ground and the erection of the necessary buildings has been in progress for nearly a year, approximately 5 miles of shedding being required for the accommodation of the stock and machinery exhibits. In addition, as a precaution against muddy conditions underfoot, some 30,000 railway sleepers were laid in the main avenues. Some of the prominent items in the programme of the show are the parade, in the Grand Ring, of British and foreign tractors, in which there is included the Ivel agricultural motor, an internal combustion-engined tractor, built in 1902, by Mr. Daniel Albone, of Biggleswade; an historical display of farm implements and machinery made 100 years ago; demonstrations of farriery and ironwork in a well-arranged forge, and, in the Ministry of Agriculture's extensive exhibit, demonstrations on making a concrete road and examples of farm roads constructed from local materials. The forestry exhibition contains some interesting timber specimens, and throughout the week there have been useful demonstrations of saw-sharpening and setting.

Nearly half this large showground is required for the display of the variety of machinery and equipment which is now such an important part of the agricultural industry. The exhibits cover just about all the equipment needed for every branch of farming and market-gardening, and range in size from a large scale modern crop-drier to a nose-ring for a bull! We continue below illustrated descriptions of some of the implements and machines which are being shown.

G. W. Wilkin, Ltd.

Among the exhibits at Cambridge there will be found a variety of small tractors designed specially for garden and nursery work. One which was submitted for the new implement competition is "The Farmers' Boy," shown in Fig. 5, and made by G. W. Wilkin, Ltd., Weston Park, Kingston upon Thames. Its power unit is a 1¼ h.p. four-stroke, air-cooled petrol engine, with flywheel magneto and automatic governor and auxiliary throttle control, the petrol consumption claimed by the makers being half-a-gallon for five hours' running. Transmission is by totally enclosed roller chain, operating in an oil bath. A power take-off with a 3in diameter pulley, running at 2000 r.p.m. to 2500 r.p.m., is included in the standard equipment. The handlebars are adjustable for height and are offset and, with 13in diameter tractor-tread pneumatic wheels, the track is adjustable from 10in to 14in. The equipment of the tractor includes a general purpose plough, as shown in our illustration, with 10in disc coulter and 22in by 4in metal cleated wheels, with stepped axle, and a further chain reduction drive. There is also a parallel axle for use with these large cleated wheels, which, together with an extension tool-bar bracket and a 24in tool-bar, allows for straddling crops for double-row cultivation or for

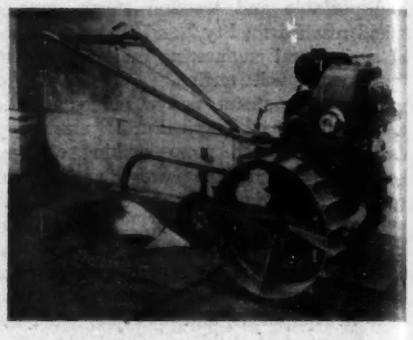


Fig. 5—Horticultural Tractor—Wilkin

8in disc harrowing, the discs being in two banks of three. Among the additional equipment which the tractor can work is a power-driven rotary hoe, a rotary scythe, giving a 16in cut, a saw bench and frame with a 12in circular saw, and a pump delivering up to 2 gallons a minute. The working speed of the tractor is given as 1½ m.p.h. to 2½ m.p.h.

Taskers of Andover (1932), Ltd.

Hydraulic and screw tipping trailers of various capacities are prominent among the exhibits of Taskers of Andover (1932), Ltd., Andover, Hants. At the same time, this firm is showing a number of farm implements, which include a simple fertiliser distributor for attachment to a trailer. The accurate distribution of artificial manures is a farming operation which is becoming increasingly important, and it is one which is now fully mechanised. The Paterson fertiliser distributor, which is illustrated in Fig. 6, has

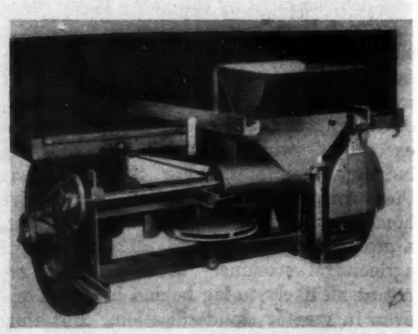


Fig. 6—Fertiliser Distribution—Taskers

been designed in order that placing of the material on the land may be effected directly from the vehicle which transports it to the field. The fertiliser is placed in a steel hopper and is fed by an auger on to the rotating disc which does the distribution. The distributor is easily mounted by sliding it on to supports previously fixed to the floor of the transporting vehicle, the rotation of the auger

being effected by a vee-belt drive from the vehicle's land wheel, as shown in our illustration. The ratio of auger rotation speed to land speed determines the quantity of fertiliser placed per acre, but the ratio can be varied by a choice of four pulleys. The distributor disc, however, is rotated independently by a small air-cooled petrol engine which can be easily removed, if required, for other work. This independent drive ensures that the width of spread remains constant at about 30 to 40ft, which has been found satisfactory at whatever speed the transporting vehicle travels.

Tractors (London), Ltd.

An interesting addition to the range of light tractors made by Tractors (London), Ltd., Bentley Heath, Barnet, Herts, is the "Trusty Steed," shown in Fig. 7. It is a four-wheeled machine, which has been built for arable farm work, and which can also be used for many farm transport jobs. The power unit is a single-cylinder, four-stroke, air cooled petrol engine of 596 c.c. capacity, which is capable of developing a maximum of 14·5 b.h.p. at a speed of 2200 r.p.m. The gearbox provides for three forward speeds of approximately 2, 3½ and 5 m.p.h., and a reverse speed of 1½ m.p.h. The engine and gearbox are assembled as one unit and are attached to the chassis by four bolts. The four-plate Ferodo-lined clutch, which incorporates a rubber shock absorber, is mounted on the input shaft of the gearbox, and is foot-pedal operated. Transmission is by roller chain to a ball bearing mounted countershaft, and thence by two further roller chains to two spur reduction units driving the rear wheels. Dog clutches are mounted on splines on the ends of the countershaft engaging the drive to the two reduction gear units, and each dog clutch can be disengaged independently by levers arranged on either side of the driver's seat. Marles steering gear, of 15 : 1 ratio, and with a 16in diameter wheel, is provided to give light steering under all conditions.

The chassis of the "Trusty Steed" is of all-steel welded construction, and has been designed so that there is maximum clearance between the wheels, and an unobstructed view of any implements which may be mid-mounted. The wheelbase is 51½in, and the track is adjustable from 28in to 44in centres on steel wheels, or from 32in to 44in centres with rubber-tyred wheels. A lever beside the driving seat lifts both mid-mounted and rear-mounted tools simultaneously, the lift being spring-assisted. The two arms which lift the mid-mounted toolbar are arranged to restrict any sideways movement. Finally, there is a 6in diameter belt pulley, of 3½in face width, which is mounted on a pedestal bearing bracket bolted to the rear of the transmission casing, and which is chain driven by a sprocket provided on the countershaft. The pulley is arranged so that the belt drive is taken to the rear of the tractor, the normal speed in top gear being 1100 r.p.m.

David Brown Tractors, Ltd.

The many tractors exhibited at Cambridge include several heavy machines designed to meet the requirements of the larger farms, not only of this country, but also of overseas countries. David Brown Tractors, Ltd., Meltham, Huddersfield, is showing two such tractors, which have lately been added to its "Cropmaster" and "Trackmaster" series. These machines, it can be said, are both intended primarily for overseas markets.

The first, which we illustrate in Fig. 8, is known as the "Cropmaster Diesel 50." It is powered by a David Brown six-cylinder diesel direct injection engine, which gives 45 b.h.p. at a normal governed speed of 1600 r.p.m. The transmission is through a conventional clutch to a twin-range three-speed gearbox, providing six forward and two reverse speeds, the forward speeds ranging from 1·33 m.p.h. in first gear low to 13·55 m.p.h. in third gear high. A four-speed power take-off unit which is integral with the tractor's rear axle, gives shaft speeds ranging from 233 to 1225 r.p.m., with engine running at 1600 r.p.m. A belt pulley mounted on the near side of the tractor gives an estimated belt horse-power of 38·5, with the engine running at 1600 r.p.m. The "Cropmaster 50" has been designed for working trailed implements—such as a five-furrow plough—and is equipped with a lateral-swinging drawbar, the movement of which can be limited from 10in each side of centre by stop pins. Another point about the tractor is the provision of extended rear axle shafts for rear track adjustment. The shafts allow also for the fitting of twin rear wheels, a practice which is favoured by some farmers when working soft land. The standard rear tyre size is 11·00 by 38, but oversize tyres can be fitted to meet the special needs of overseas countries. The brakes operate on the rear axle shafts, the drums being fitted externally. Independent foot pedals give immediate braking, and, if desired, the controls can be locked together and applied jointly.

The other new tractor exhibited by the firm is the "Trackmaster Diesel 50," which in most respects is similar to the "Trackmaster," described and illustrated in our issue of December 15, 1950. The essential difference is that a six-cylinder instead of a four cylinder diesel engine has been installed developing 50 b.h.p., at a governed speed of 1800 r.p.m. The steering is arranged on the makers' "Duotrack" system, and the tractor is operated by 11in diameter oil-immersed hand brakes which are coupled to 30in hand steering levers. The "Trackmaster 50" is being offered with a choice of three track widths, 48in, 56in, or 64in, with alternative 14in or 16in track plates. The four-speed power take-off, which is integral with the rear axle casing, gives a shaft speed range from 467 to 1792 r.p.m., and an 8½in diameter belt pulley, which may be fitted at the rear of the power take-off shaft, can be run at the same speeds.

In company with its tractors, the firm is showing a full range of mounted implements. There are eight new implements, including a robot hole digger, a Tamkin mounted concrete mixer of 5 cubic feet capacity, a Blaw-Knox bulldozer, designed for operation with the "Trackmaster" tractor, a two-row cabbage planter, a Belton beet hoe, Parmiter flexible harrows, a two furrow one-way plough, and a McConnel hedge cutter.

Byron Farm Machinery, Ltd.

The growing use of combine-harvesters in this country has led to the necessity to store quantities of grain on farms, where formerly it was threshed periodically or at the time it was sold to a corn merchant or miller. Those responsible for grain processing—driers and millers, for example—receive grain in bulk and deliver it in bulk. It is, therefore, advantageous for the farmer, also, to store it in bulk and so eliminate repeated bagging and emptying.

A pneumatic grain conveyor, which has a capacity of 80 English bushels an hour, a length of carry of 100ft, and a lift of 20ft, is shown by Byron Farm Machinery, Ltd., Blackhorse Lane, Walthamstow, E.17. A photograph of a low hopper model, i.e., with a hopper height of 33in, is reproduced in Fig. 9. The equipment can be driven at a speed of 2000 to 2200 r.p.m. by a tractor, electric motor, or any power unit developing 4 h.p. The main body of the conveyor is constructed from heavy steel plate, the 2ft 6in square top hopper, which is of reinforced steel sheet, holding four bushels. The fan, mounted on two ball-bearing self-

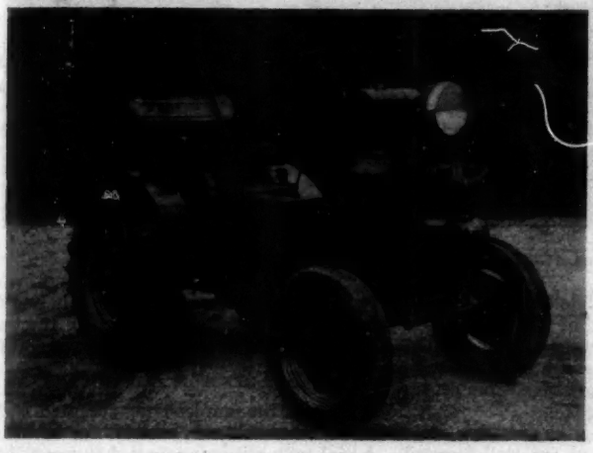


Fig. 7—"Trusty Steed" Tractor—Tractors (London)

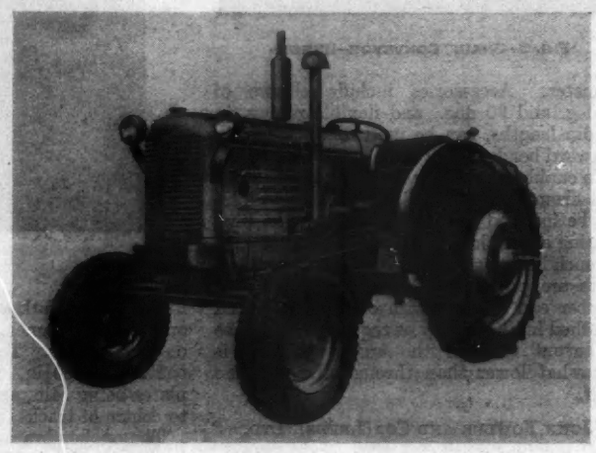


Fig. 8—"Cropmaster Diesel 50" Tractor—David Brown

aligning plummer blocks, is belt-pulley driven, normally at 2000 r.p.m. The machine can be fastened to the floor by its flanged feet, or there is available a standard base frame, with or without wheels, on which the machine and an electric motor can be mounted. The delivery pipes for the conveyor are in 3ft lengths and are 6in in

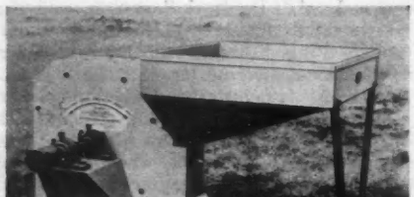


FIG. 9—GRAIN CONVEYOR—BYRON

diameter. Accessories include elbows of 45 deg. and 90 deg., and flexible piping, in 2ft 6in lengths, can be used for particularly awkward bends.

To enable the machine to be used to empty bins from ground level, an auxiliary inlet can be inserted at any point along the pipe running along the ground, or, if necessary, in a trench below ground level. These auxiliary inlets are provided with shutters so that a number can be used with one pipe line and switched in alternately as required. The rate of output through the auxiliary units is somewhat lower than through the machine itself.

JOHN FOWLER AND CO. (LEEDS), LTD.

In Fig. 10 there is reproduced a photograph of a Mark VF diesel crawler tractor, pulling a five-furrow heavy plough. The tractor is among those shown by John Fowler and Co. (Leeds) Ltd., which firm is now associated with Marshall, Sons and Co., Ltd., Gainsborough. This tractor has a Marshall single-cylinder diesel valveless two-stroke engine, having a bore of 6½in and a stroke of 9in, developing 40 belt horse-power at a governed speed of 750 r.p.m. There is an easily-accessible spring loaded, multi-plate clutch, and spur gears mounted on short transverse shafts provide a straight through drive to a controlled balanced power steering unit. The six forward speeds are from 1·26 to 5·42 m.p.h., and there are two reverse speeds of 0·96 and 2·24 m.p.h. The heavy rolled steel channel track frames are hinged on a pivot beam which is mounted on the transmission case side covers, the track recoil unit being anchored direct to the rear track frame pivot bracket. The front idler is mounted in a fork and slide brackets located on the track frames, each of which is carried on four rollers. The tracks give a ground contact of 60½in, the width of the track plates being 14in, and the gauge, from centre to centre of tracks, being 56in.

The anchor bracket for the swinging draw bar of the Mark VF is placed well forward under the transmission casing, and the drawbar support plate is provided with offset location slots to ensure that pull loads are always taken by the anchor bracket. A belt pulley, 15in diameter and 6½in face, is fitted to the nearside of the tractor, and is operated by the engine clutch. The maximum belt speed is 2950ft per minute when the engine is running under full load at 750 r.p.m. Provision is also made for a power take-off, with a shaft speed of 550 r.p.m., which is driven by bevel gearing from the transmission.

Another Fowler exhibit is the "Challenger Mark III" heavy duty diesel crawler tractor which is now being built primarily for land reclamation and clearance schemes. The engine is a Meadows six-cylinder four-stroke diesel, developing 95 b.h.p. at 1550 r.p.m., and providing 82·4 h.p. at the drawbar. There are six forward speeds between 1·50 m.p.h. and 5·67 m.p.h., and four reverse speeds between 2·08 m.p.h. and 5·13 m.p.h., and the weight of the tractor in working order is approximately 23,600 lb.

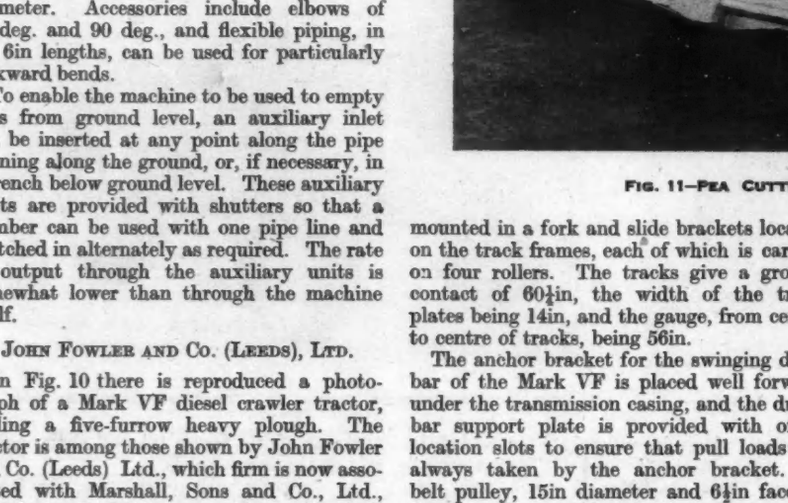


FIG. 10—DIESEL CRAWLER TRACTOR WITH 5-FURROW PLOUGH—FOWLER

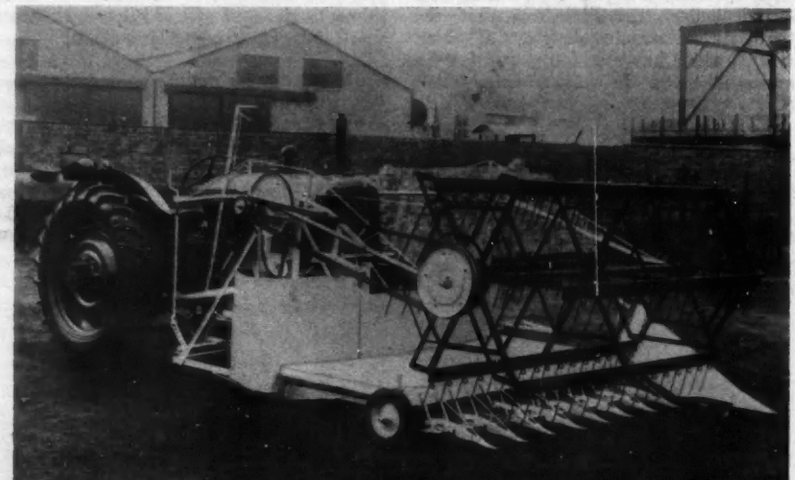


FIG. 11—PEA CUTTER AND SWATHER—LEVERTON

H. LEVERTON AND CO., LTD.

Among the implements accepted by the Royal Agricultural Society for the silver medal competition was a pea cutter and corn swather, which has been developed by H. Leverton and Co., Ltd., Spalding, Lincs, and is one of that company's exhibits. The machine which is illustrated in Fig. 11 has been designed to deal with the cutting of vining peas, harvest peas, and various corn crops. It has now been fully tested in the field.

The cutter-swather is a hydraulically-controlled front mounted tractor implement. Power from the tractor power take-off is transmitted to a forward-mounted belt drive mechanism which rotates a pick-up reel and drives a cutter bar and a canvas cross elevator. The machine has an 8ft cutter bar, and its cross elevator, which is made of brown proofed canvas, is 3ft 6in wide, thus allowing heavy corn crops to be windrowed without congestion. The reel, which is of large diameter, is adjustable for variation of crop conditions, by hand control from the tractor driver's seat when the machine is in motion. The drive is taken from the rear of the tractor to the front by chain and telescopic shaft and is then transmitted to the reel and cross elevator by leather vee-belting and to the cutter bar by a sway bar. An automatic safety clutch is incorporated in the main drive at the rear of the tractor. As the implement is front-mounted, it is possible to drive it at various speeds to suit prevailing crop conditions. Under average conditions, the makers claim, the machine is capable of dealing with between fifteen and twenty acres of harvest peas a day.

Another new implement which is now being developed by the firm, and is exhibited, is a tractor-operated potato haulm cutter. Centrifugally-acting weights lift the haulm on top and between the rows of potatoes to a series of rapidly rotating cutter blades.

(To be continued)

International Conference of Naval Architects and Marine Engineers

No. I

THE International Conference of Naval Architects and Marine Engineers was officially opened on Tuesday morning, June 26th, in the Central Hall, Westminster, by the Lord Mayor of London, Alderman Sir Denys C. F. Lowson, who was accompanied by his Sheriffs and the Mayor of Westminster. The Lord Mayor in a short speech welcomed the delegates, especially mentioning Vice-Admiral E. L. Cochrane, of the United States Navy, and extended to them the good wishes of the City.

Viscount Runciman of Doxford, the President-Elect of the Institution of Naval Architects, presided, and he thanked the Lord Mayor for his presence and his interest in the conference and stated that Viscount Cunningham of Hyndhope was unable, unfortunately, to preside owing to illness. The meeting unanimously agreed to send a message to Viscount Cunningham, expressing its wish for his speedy restoration to full health. The Chairman mentioned that Mr. Winston Churchill was unable to attend the conference but had sent a message conveying his good wishes, and expressed the thanks of the delegates to Sir Ronald Garrett and the committee of Lloyd's Register of Shipping for their hospitality at the pre-conference reception. Dr. S. F. Dorey, President of the Institute of Marine Engineers, seconded the vote of thanks to the Lord Mayor and reminded those present that although London was no longer a shipbuilding and marine engineering centre it was pre-eminent as a shipping port.

The first paper presented was :—

SHIP'S STRUCTURES—A CENTURY OF PROGRESS.

By R. B. Shepheard, C.B.E., B.Sc.

Synopsis

The paper views the present scene against the background of historical development and from this standpoint looks to find guidance for future progress. With the repeal of the Navigation Acts one hundred years ago, the increase in seaborne trade and the advent of the steam engine and the iron ship, British shipping entered upon a period of vigorous expansion, reaching a total of 8½ million tons by 1870. The work of I.K. Brunel and J. Scott Russell is linked with the "Great Britain" and "Great Eastern" and reference made to an early system of longitudinal framing.

Changes in the distribution of material in the midship section are discussed and also oil tanker structural developments. The methods of assessment of longitudinal bending moments are mentioned and tables give bending moment factors for a number of ships. Problems related to the buckling of plating are considered, together with the investigations by Lloyd's Register into the behaviour of riveted and welded connections. The growth of welding is traced, attention being paid to the question of brittle fracture and the modifications introduced by the classification societies to eliminate deficient material. The paper concludes with a note upon the present scope and volume of research.

Discussion

Mr. D. P. Brown (U.S.A.): Recent revisions in the Rules of our two Societies have brought them more closely into agreement in so far as the distribution of material and the basic overall strength characteristics are concerned. One of the sub-headings in the paper referred to welding as the second revolution but the introduction of this method of connection has not involved such radical changes in the basic concepts of structural design as did the transition from wood to iron or to a lesser degree from iron to steel. This new medium has introduced new problems, the importance of which was not fully realised before welding was extensively used. Some of the fractures in the welded ships had their inception in such members as bulwarks, bilge keels or even in mouldings, which had been fitted to prevent chafing, items to which only casual attention had been paid with riveted construction. Experience has shown that the large welded structure is susceptible to poorly designed details and faulty workmanship, so that if the full benefit of the experience to date with welded ships is to be obtained it is essential that careful control be established in the drawing office and also during building.

The introduction of welding has not been accompanied by a complete change in constructional material, nevertheless, experience with welded ships has brought into prominence a property of shipbuilding steel which was not of great significance with riveted construction. Investigation of steel from fractured ships indicates that the material complied with all the standard tests relating to tensile strength, yield point, ductility and bend tests. Exploration of other properties was made to explain the sudden brittle manner in which those fractures developed and there came into prominence the property described as notch toughness, which is not directly related to the other ordinary physical properties. Testing of steel from ships in which fractures have occurred has indicated a low degree of notch toughness and, where the fractures had terminated, the material at the terminal has shown a higher degree. Universal agreement has not yet been reached as to the most reliable test to establish a measure of notch toughness nor as to definite quantitative values to be associated with any particular type of test to provide a reasonable assurance against the inception of or the propagation of fractures in the large welded structures but laboratory research is still being carried on to solve this problem.

Through the recent action of the classification societies in modifying their specifications for hull steel plates, practical advantage has been taken of the knowledge so far acquired and subsequent investigations of steel supplied to the new specifications have consistently supported the action taken.

Sir Charles S. Lillicrap (Great Britain): The basic problem when designing a vessel is that it must carry the largest possible amount of cargo and to achieve this the hull structure, which forms the major part of the light weight, must be reduced to a minimum. The author has shown us the improvements that have been made over the past century and they form a constant reminder that we must continually improve the materials we use and use them to the best advantage.

I would like to make a strong plea that everybody connected with the shipping industry should make every effort to ensure that any Act, which mitigates against the design of efficient structures by stressing considerations other than strength and safety, is amended or removed.

It appears that the increase in the liability of compressive deflection occurring in the bottom plating of vessels has been enhanced by the greater use of welding in the bottom structure and that this has coincided with the tendency of the hogging moments in dry cargo ships to increase. In the riveted ship the lap joint with its local stiffening effect tended to break down the size of the panels and the absence of shell flanges of welded stiffeners means that with the same frame spacing the unsupported width of plating is greater. The effects of these two items are probably just sufficient to reduce the critical stress in the welded ship to the point where some crippling takes place.

Scott Russell recognised the improvement in efficiency obtained by adopting longitudinal framing in the double bottom and strength deck almost a century ago but it has taken many years for these principles to come into use. Longitudinal framing, especially of the double bottom, has been used for many years in the design of naval vessels and is coming more and more into prominence.

With regard to the rapid change over to welded ship construction, I would like to amplify the Scott Russell quotation by adding that it might be said that the traditions of the riveted ship have done harm to the construction of welded ships for the initial tendency was to imitate instead of designing for a new medium.

J. C. Arkenbout Schokker (Holland): I fully agree about the advantages of the longitudinal construction. To the two points mentioned, namely greater longitudinal strength and greater resistance to buckling, I would add another advantage. In a transversely-framed vessel the longitudinal stress in the bottom plating and the stress set up by the water pressure on a panel between the floors are working in the same direction and therefore give rise to stresses which can amount to 13 tons per square inch. With longitudinal framing the stresses from the water pressure are perpendicular to the longitudinal stresses. So that the virtual stresses are lower, say, 9 tons per square inch.

With regard to the strength of riveted against welded butt laps, Montgomerie's experiments showed a falling off in the case of heavier plates. So that it can be understood that the crack in the strength deck of the "Majestic" found its way through a butt in this deck. As to the "Neverita" and the "Newcombia," the bending moments were lower than may be experienced in a seaway and it is not certain that the strength of both vessels would also be equal in the latter case.

Mr. David Arnott (U.S.A.): The author states in the paper that "Simplification and removal of redundant members in the internal structure proceeded slowly and only by the end of the first decade of the present century had the stage been reached of assessing scantlings of individual components on comparative determinate methods to suit their particular functions." If he means that progress started only when Lloyd's devised their rules in 1906, then I must point out that at an earlier date rules had been prepared by Jefferies, who died before they were published; Mr. Foster King carried on and I think Mr. Archibald Denny (later Sir Archibald) also did some research.

Professor Dr. G. Schnadel (Germany): It seems to me that the merits of Brunel are not given full recognition. He was in fact the designer of the first sea-going steamer, "Great Western"; he was the builder of the first ocean-going iron ship, "Great Britain," propelled by a screw and mechanical gear, and the ships he built had the modern features that were proposed later by Fairbairn and Scott Russell.

The longitudinal system of ship construction was used on the orders of Brunel in the structural design of the "Great Eastern," the plates of the strength deck being doubled and longitudinally stiffened. He recognised the importance of the longitudinal bending moments for the strength of a ship, but Mr W. John, of Lloyd's Register, made a useful proposal for the calculation of those moments, and his proposal remains the basis of comparison to this day. I think we should not make the Smith correction, using a wave with a height of one-twentieth the length of the ship, as the actual waves in the ocean have a height of one-twelfth the length of the waves.

There are points to be considered in calculating bending moments for the wave pressure is not evenly distributed along the ships' length with trochoidal form. Measurements of the pressure on the bottom of the "San Francisco," the "Ocean Vulcan" and "Clan Alpine" have shown that the pressure is much lower amidships than that calculated with the Smith correction; and it is at the bow and stern that the Smith correction is most nearly applicable. Over the midships half of the ship the form of the pressure curve is very flat and this means that the hogging moments are smaller than sagging moments.

With regard to the buckling stress of plating under compression, a double advantage is gained by longitudinal framing. Most designers, including Brunel, have believed that the longitudinal girders are the most essential addition to the longitudinal strength of the ships; but the buckling strength of the shell and the strength deck, of the longitudinally-framed ship, is in itself much higher than the buckling strength of the transverse-framed ship. That is the reason why the longitudinal ship has high resistance to compressive stresses, even in the case when the longitudinals are cut off at the bulkheads, and is to be preferred to the transverse-framed ship, especially in the case of the tanker. Longitudinals only contribute to the strength in tension if they are not cut off at the bulkheads for there is then no weak point at the bulkhead.

I believe it is not possible to determine the buckling stress of transversely-stiffened plating by experiments with unstiffened samples, for we have found that the buckling stress is influenced to a high degree by the stiffness of the deck beam and the stiffness of the beams is as essential as the thickness of the plating.

The slipping of the rivets is not essential for the modulus of elasticity. We have done some research on this question and have found that the longitudinal connections, in the normal range of stress, do not slip. We have established, in an experiment with a 1000-ton testing engine, that rivets in an end connection will slip only to a very small degree if the stress is higher than 13 tons per square inch and also that an overlap is better than a butt strap. In the destroyer "Wolf," the larger deflections were caused by buckling of the plating, not by the slipping of the rivets.

The improvement in building methods and the adoption of large panel connections, introduced by David Arnott into the welded ship construction, represents important progress. As far back as 1939 we advised German shipyards to use riveted stringer angles to prevent a breakdown of all-welded ships.

The second paper to be read was "B.S.R.A. Resistance Experiments on the 'Lucy Ashton,' Part I: Full-scale Measurements," by Sir Maurice E. Denny, Bt., K.B.E., S.B., an abstract of which appears in this issue on page 15.

Sir Maurice Denny, after introducing the paper, said: Since the paper was written certain results have become available of which I may give an outline.

The programme of tests for the "Lucy Ashton" included some work on the increase of resistance due to fouling, as the data would be of value to shipowners and also to shipbuilders, who have had experience on the trials of sister ships, of wide discrepancies in the power required which could only be ascribed to fouling. Some discrimination must be observed in interpreting the final results because the water temperature was not constant over the period, rising from 43 deg. Fah. at the end of March to 59 deg. Fah. in early June. On stripping the ship the hull showed a fine growth of short "grass," while on the bottom of the ship there was a general but light scattering of tiny limpets. By this time, at what might be a normal service speed, the total resistance had increased by round about 28 per cent. This figure is larger than would be expected from the results given in the paper, obtained during the months of December and January, and suggests that water temperature has a large effect on fouling. In terms of surface friction a fair mean for the increase would be about 0·6 per cent per day.

Discussion

Sir Charles S. Lillicrap (Great Britain): It was eighty-two years ago that a committee appointed by the British Association for the Advancement of Science rendered a report "on the state of existing knowledge on the stability, propulsion and sea-going qualities of ships and as to the application which it may be desirable to make to Her Majesty's Government on these subjects." One recommendation was that the resistance of a full-size ship should be determined by towing it at sea. Trials of at least two ships were proposed, considerably different both in size and proportions and with different conditions of smoothness of surface.

William Froude signed the report, subject to an explanation regarding ship resistance. He described his theory of ship resistance and enumerated the Law of Comparison. He agreed that a dynamometric determination of the resistance of a full-size ship was necessary but considered that model experiments would be more fruitful of useful results at much less cost. He supported his views by giving the results of the tests of some models he had carried out in the River Dart. The difficulties foreseen in towing a ship were fully confirmed when trials were carried out two years later on H.M.S. "Greyhound."

The foundations of ship model research laid by William Froude have been strengthened by many years of experience, although the results of the "Greyhound" trials did not afford full support for the Law of Comparison. It has been realised for years that the method of computing skin friction resistance requires verification or modification before it can be accepted in an absolute sense. Useful advances in our conceptions have been made by experiments on planks and models in ship tanks, but the real requirement is to obtain reliable information on actual ship resistance.

I am sure that we can feel complete confidence in the accuracy of the results of the trials. The instrumentation speaks for itself; and the pains taken are manifest but the real key is the method of propulsion. Those who have had experience of towing problems know of the great distance astern at which the screw race of the towing vessel can have a material effect on the resistance of the towed ship, so that the application of jet engines has disposed of the serious source of inaccuracy consequent on interference.

The results on the trials have been obtained at a Reynolds' Number as large as 375 million. B.S.R.A. were keen to obtain results at higher Reynolds' Numbers and I was approached with the proposal that such trials might be carried out with a small warship. I made proposals to the Admiralty that tests on the lines of the "Lucy Ashton" trials be carried out with one of H.M. ships and if these proposals are approved, results will be available at even larger Reynolds' Numbers.

Dr. F. H. Todd (U.S.A.): The United States Navy has a continuing programme of skin friction research covering experiments on planks and model vessels, and full-scale ship trials. In the model basin we have on each side of our models and planks a plate which can be removed and sent to the shipyards to be painted under the conditions in which ships are painted after painting it is again fixed on the models. In that way we take measurements of the relative resistances of different paint surfaces on the actual ships and attempt to correlate the physical characteristics of the surfaces and the resistance. Most of our full-scale trials have been done with thrust meters fixed, so that we can assess the thrust, and the gap between the apparent skin friction of the ship and that predicted is called the roughness allowance. We have results of four recent merchant ship trials, there being three tankers of about 600ft and one passenger ship somewhat larger. The allowances necessary to balance the resistance of the ships and that predicted from the models varied between 10 per cent and 37 per cent.

It is proposed to carry out work, similar to that described in the paper, on two types of vessel, one being a small twin-screw naval ship and the other a single-screw tug. We shall use thrust meters and propulsion by aircraft engines will be used to determine the ships' resistance.

Dr. J. F. Allan (Great Britain): In the "committee" stage there was in the Research Association a good deal of doubt concerning the possibility of carrying out this work but never any about its desirability.

The main features of the paper are the tremendous efforts made to achieve accuracy in every direction and the success achieved in producing a steady, uniform propulsion by means of the jet units and the results throw light on the difficult problem of correct correlation between ships and models. We have here an important link in the chain which will enable us to make the change over from the resistance basis to a more fundamental basis.

Mr. R. W. L. Gawn (Great Britain): The real key to success is the method of propulsion, which disposes of any source of inaccuracy inherent in the effects of interaction from a towing vessel. The instrumentation has been so thoroughly considered and the trials executed with such skill as to ensure a high standard of accuracy of records.

With regard to the depth of water in the trial area, 17 fathoms, that is truly deep water for the purpose of this trial and the results will not be influenced by any restrictions due to limitations of depth. I mention the point because William Froude tested a model of the "Greyhound" in water of restricted depth and found that the resistance was increased. He concluded

that the correction to the curve of resistance calculated for the ship from the experiments with the model would considerably improve its agreement with the actual curve of resistance of the ship. It was mentioned in the paper that the "Greyhound" ship trial results did not agree with the model experiment results and that was one of the reasons. This leads to the suggestion that if possible it would be useful to arrange for some trials of the "Lucy Ashton" in shallow water.

Those interested in practical results must be impressed by the figures showing the combined effect of fairing the seams and applying a smooth paint, a reduction of hull resistance of the order of 6 per cent, which may be expressed as equivalent to a reduction of about 9 per cent of skin friction resistance.

This suggests that there is scope for the development of bottom compositions which will be at least as smooth as that applied to the "Lucy Ashton."

Sir Maurice has suggested this morning a figure of 0·6 per cent per day as the mean increase of surface friction due to spring and early summer fouling of the "Lucy Ashton." That is a high figure, and perhaps he could tell us the service of the ship during that period. Was she laid up during that time, because Admiralty experience gives ¼ per cent per day for general service?

Neither the profile of the wave against the side of the ship nor the sinkage of the ship in space at various speeds is mentioned. This information would be useful and afford a check on observations usually made during routine model tests.

Professor E. V. Telfer (Great Britain): I should like Sir Maurice to include in the paper and in his reply a section of the vessel showing the actual seams so that we can check up on seam resistance by the methods I put forward in my paper.

The amount of difference in roughness resistance shown according to the different qualities of paint is extremely interesting and shows clearly that a new line on paint should be undertaken on behalf of the shipping industry in order that we may profit to the utmost from the new designs of ship structures. I feel that with the ordinary riveted construction the butt resistance would be dominant and would not allow the improved smoothness of the paint to be felt to the fullest extent. It may be possible on the "Lucy Ashton" to simulate types of butt construction by fitting a reverse ridge, so that the butt resistance in the older ships, of which we have a great amount of information, could be correlated with the results of tests on the "Lucy Ashton."

Sir Maurice Denny, in his reply, said Dr. Todd referred to the trials of four large ships in America, where the thrusts of the engines were measured, presumably by some reliable thrust meter and then, after making a certain assumption, the resistances of the ships were deduced. He told us that the results in terms of apparent roughness seem to vary very widely and from my own experience and that of other shipbuilders who have run ships and especially sister ships, on trial, I suspect there were really substantial variations of the ships on trial.

Mr. Gawn asked for photographs of the waves or measurements of wave profiles on the "Lucy Ashton" while under way, and he asked whether there have been measurements of bodily sinkage. I think the answer to the question on bodily sinkage is "no." About wave profiles I am sure that photographs were taken on the ship.

Professor Telfer has asked for a section to show where the seams were. That will be given to him with great pleasure.

He also suggested that the "Lucy Ashton" might go out once more on trial with little pieces of wood tacked around her in order to enable the resistance of butts to be measured. The "Lucy Ashton" has had her four jet engines removed and we are hoping that she will not need to do more trials.

(To be continued)

A Large Road Trailer

DURING recent years the size and weight of individual loads carried on the roads in this country have been steadily increasing and numbers of special trailers for this class of work have been built. A particularly interesting vehicle of this kind, which was recently designed and built by Cranes (Dereham), Ltd., of Dereham, Norfolk, for Robert Wynn and Sons, Ltd., of Newport, Mon, is illustrated in the photographs and drawing we reproduce herewith. The payload of this trailer is 120/140 tons and the vehicle is capable of carrying gross loads of 180 tons at low speeds. Lighter frame members can be substituted for some kinds of loads, giving increased net capacity.

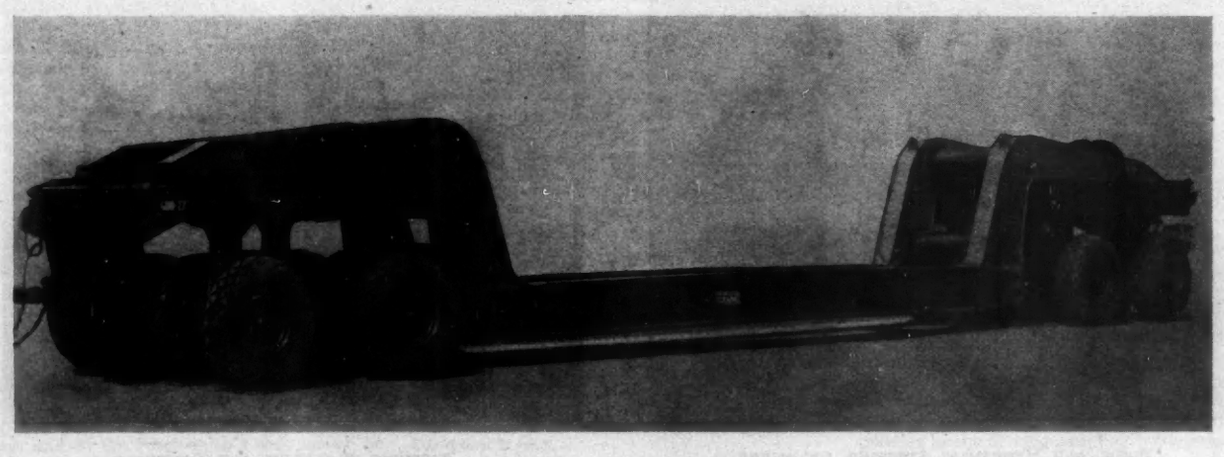
The vehicle consists of two eight-wheeled bogies, two swan-neck units and a main frame. The main frame is built up of two fabricated longitudinal box-section main beams, each formed by a pair of rolled steel joists with top and bottom flange plates. At their ends the beams are coupled together by flanged tubular cross members, and tie-bars are spaced along their length. The frame illustrated provides a deck 27ft 3in long and just over 2ft deep, but a variety of frames can be supplied, which can be longer, higher, or different in other respects, for use with the bogies.

The swan-necks, which support the frame from the bogies, have "shovel-mouthed" lower ends, in which the ends of the main frame are enclosed and supported. The ends of the necks and main frames are rigidly locked together by means of turnbuckles, which can be fitted either on the inside or the outside of the frame, as dictated by the load. The swan-necks are of box-section and are built up of fabricated plates, and the two main beam units of each assembly are coupled together by flanged tubular cross members. A point of particular note is that the swan-necks and main frame members can be assembled in accordance with the width of the load to be carried. Overall frame widths from 4ft 6in to 15ft 6in can be obtained by using six sets of cross tubes, which form the cross members, either singly or in combination, as shown in one of the illustrations.

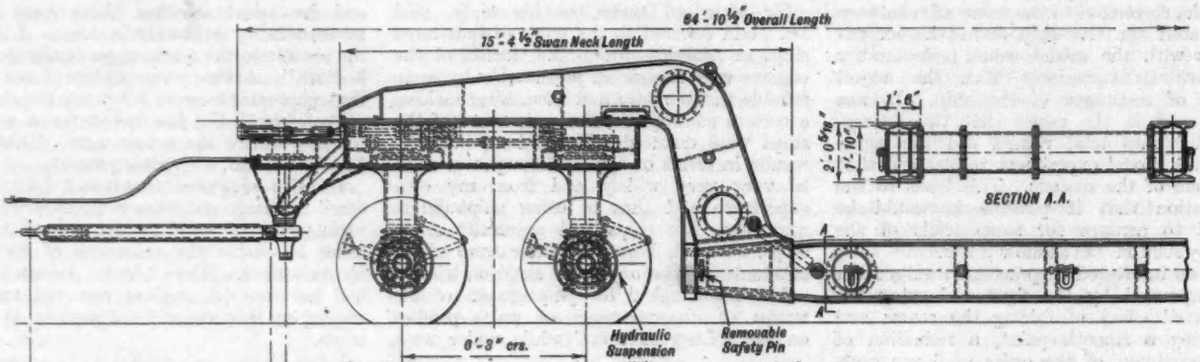
Each of the bogies has a fabricated frame about 18in deep and provision is made for fitting outriggers at each corner for the attachment of the frame and swan-neck members when they are extended to their maximum width. As already mentioned, the bogies are mounted on eight wheels, which are fitted with 16·00 by 20, twenty-four-ply pneumatic tyres. Four short axles on each bogie are pivoted on their centres in order to allow individual movement.

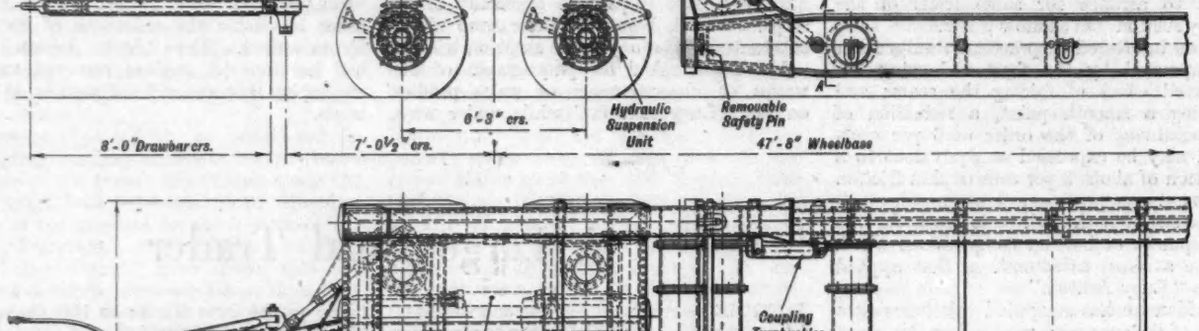
A 9in diameter hydraulic ram above each axle centre can be used to raise or lower the load in order that it may clear low railway arches, &c. These rams are self-adjusting to allow the flow of the oil from the front cylinder, or cylinders, to the rear, or vice versa, to equalise the loading on each pair of tyres. They can also be used to tilt the frame of the vehicle with its load towards either side for clearance or balancing purposes. The hydraulic plunger movement is simply a sliding one as the cylinder is arranged to rotate with the axle when necessary for steering. At the head of each cylinder the fluid passes through a rotary joint, which has been designed by the makers to permit the feed from one to the other cylinder on the same side of the bogie to pass freely through 1¼in bore hydraulic tubing.

Each piston has a "Gaco" seal at its head and also an "O" ring. This ring is intended to prevent air being drawn in should the axle be called upon suddenly to negotiate a cavity in the road surface, which would result in the flow of oil being too slow to prevent a vacuum. The upper plunger guide is in the form of a separate machined high-



120 TON ROAD TRAILER





ARRANGEMENT OF BOGIE AND CHASSIS MEMBERS

grade iron casting and at the lower end of the cylinder there is a massive bronze bush.

Cylinder lubrication is provided by a grease ring at the upper end, supplied from a nipple at the lower end.

In order to make the fullest and most effective use of such a large vehicle, an effective means of steering is of particular importance and a hydraulically operated steering gear is fitted. Both bogies can be steered in any one direction at the same time and the four axles of each bogie can be caused to turn through 90 deg. in either direction by a second hydraulic system, or by drawbar control. When in operation the rear end of the vehicle will generally be separately steered by a steersman riding on a small platform at the extreme rear. At this point simple controls are arranged to bring hydraulic steering cylinders into action by the movement of one of a pair of three-way valves, each of which operates a double-acting cylinder. The valves on the right side, for example, are used to steer the rear bogie to the right of the road and when the lever is placed in the alternative position it will cause the wheels to return to the straight. The same thing happens in reverse on the other side of the bogie.

The four axles can be pivoted simultaneously through 180 deg. and this movement is effected by a novel system of chain steering, which couples all four cylinder heads together and is operated from the drawbar post. Each link of the chain is of sufficient length to pass along one side of each chain wheel, which, in effect, is of square construction, and this makes it possible to include a positive pinning position to each of the five steering heads. Set in a link between each steering head and its neighbour is an adjusting nut for correcting the steering of one or more axles.

At the upper end of each cylinder there is fitted a large angular-contact ball-bearing, which transmits the full load of 20 tons to each axle. The ram, however, is prevented from turning in the cylinder by a hinged triangular linkage situated at the rear of each axle.

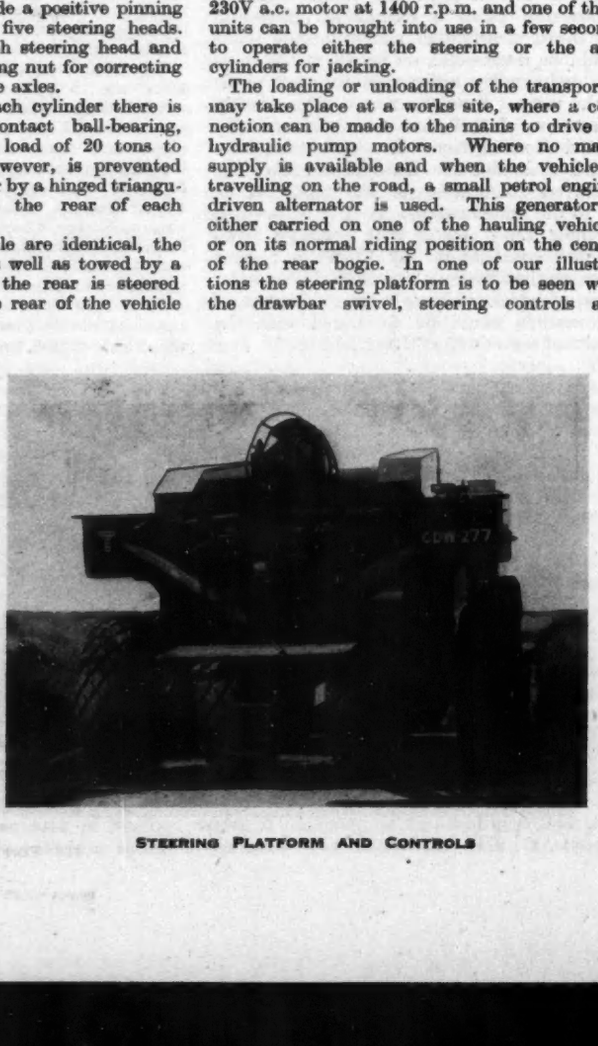
Both ends of the vehicle are identical, the front end being steered as well as towed by a triangular drawbar, but the rear is steered either by a tractor at the rear of the vehicle or by the hand-controlled hydraulic gear.

It is interesting to note that the vehicle can be completely turned round within a circle approximately equivalent to its own length, or it can be moved bodily sideways, crab fashion, by the use of two tractors.

Each bogie has mounted on it a six-cylinder high-speed hydraulic pump, which is capable of delivering fluid at a pressure of 2400 lb per square inch. Each pump is driven by a 230V a.c. motor at 1400 r.p.m. and one of these units can be brought into use in a few seconds to operate either the steering or the axle cylinders for jacking.

The loading or unloading of the transporter may take place at a works site, where a connection can be made to the mains to drive the hydraulic pump motors. Where no mains supply is available and when the vehicle is travelling on the road, a small petrol engine-driven alternator is used. This generator is either carried on one of the hauling vehicles or on its normal riding position on the centre of the rear bogie. In one of our illustrations the steering platform is to be seen with the drawbar swivel, steering controls and

BOGIE AND HYDRAULIC STEERING CYLINDERS



STEERING PLATFORM AND CONTROLS

linkage and the generator for the pump motors.

Each axle is fitted with a pair of brakes having shoes 16½in diameter by 6in wide. These Girling two-leading shoe, self-energising brakes are controlled by air cylinders worked on a special Bendix Westinghouse two-pipe line system, and all sixteen wheels can be braked from either end of the vehicle at will.

The brake linkages are individual to each axle and because of the 180 deg. of steering no hoses can be used from the bogie frame to the axle because it is possible that the tyres will at times practically contact the vertical cylinder casings. As the brake cylinder hoses cannot be arranged between the cylinders and the bogie frames, air ducts are provided in the hydraulic cylinders and a flexible hose at the head of each cylinder makes allowance for steering movements. A further hose connects each duct with its air cylinder to allow for rise and fall of the axle and piston assembly.

Mechanical brake application is by a handwheel attached to each axle. A screw operated by the handwheel passes through the air piston, which is itself stationary and applies force to the moving air cylinder, whereby the brakes can either be separately applied by the eight small handwheels, or, when fully applied by air pressure, can be locked by the handwheels.

The construction of the vehicle is such that the loading and unloading of very heavy objects can be carried out with relative ease. The procedure is for the frame to be lowered to the ground and for the swan-necks to be detached and taken out of the way on the bogies, thus leaving a clear frame on which the transformer or similar object can be placed. After this the swan-necks are attached to the frame, which is then lifted up into its normal running position. If the load is too high to pass under a bridge the frame can again be lowered nearly to the ground to give necessary clearance.

Bicentenary of Christopher Polhem

In the intellectual outburst of the Renaissance we are apt to forget that it was not only in science but also in technology that great strides forward took place. Among the early engineers of that time, one of the foremost, at any rate in his native country of Sweden, was Christopher Polhammar who has been hailed with excusable exaggeration as the "Archimedes of the North." He was born of humble parentage near Visby in the province of Gotland on December 18, 1661; he rose by his native talents to the position of the foremost civil engineer of his day, and he was ennobled by his sovereign, Charles XII, in 1714, under the name of Polhem. It is not our purpose here to go into details of his widespread activities in the fields of mining, metallurgy, industrial machinery, agriculture and hydraulics; suffice it to refer the reader to a Memorial Volume, published in 1911, by the Swedish Union of Engineers, (Christopher Polhem—*Minneskrift utgifven of Svenska Teknologföreningen*, Stockholm, 1911), to commemorate the 250th anniversary of his birth. We may, however, mention his most ambitious work—that of the Gota Canal connecting Norrkoping with Gothenburg to avoid the detour of the Kattegat, commenced in 1718, abandoned on the death of Charles XII, revived in 1746 when Polhem was 88 years of age, but not carried out in its entirety till 1808-29 with the help of the great Telford.

Our present purpose, however, is to congratulate our Swedish colleagues in having commemorated the bicentenary of the death of Polhem, which took place at Stockholm on August 31, 1751, when he was approaching his 90th year. The commemoration commenced on Sunday, June 10th, at Tingstäde, where Polhem spent his childhood. An eulogy on him was pronounced by the well-known Swedish writer, Arvid Olsson, prayers were read by Bishop E. Bjorlander, a choir and orchestra supplied folk singing, and Polhem's career was traced by Robert S. Nilsson, member of the Newcomen Society, who sent a cablegram of congratulation. A visit followed to Polhem's birthplace, close to Visby, and to the blacksmith's shop which he frequented as a boy.

Rolling Mill Design*

No. II—(*Continued from page 863, June 29th*)

Blooming and Billet Mills at the Normanby Park Steelworks of John Lysaght's Scunthorpe Works, Ltd. †

These mills went into operation on three-shift in August, 1950. The intended ingot capacity is 10,500 tons per week rolled into sheet bar, billets and slabs from ingots of approximately 4 tons weight. They consist of a 42in by 8ft 6in blooming mill and a six-stand 19in continuous billet and sheet bar mill, both electrically driven. One point that must be borne in mind in considering these mills is that they have to cater for diverse products.

The blooming mill has an ingoing rack divided into three sections of 18in diameter rollers with respectively nine rollers 5ft long with 60 h.p. drive; twenty-four rollers 8ft 3in long with two drives, 60 h.p. and 100 h.p.; eight rollers 8ft 6in long with 100 h.p. drive. On the delivery side there are two racks leading to the de-seamer approach rack.

The main electrical equipment of the 42in blooming mill is a direct current, forced ventilated, reversing machine, having an r.m.s. output of 6650 h.p. at 62 r.p.m. The cut-out torque is 230 metre tons at 62 r.p.m. The speed control is by variable armature voltage from 0 to 62 r.p.m., and by field weakening from 62 to 150 r.p.m. The minimum reversal time is not exceeding 1·5 secs. This machine is supplied by a Ward-Leonard-controlled Ilgner set, comprising a 5000 h.p. slipring induction motor coupled to a flywheel equipment having a stored energy of 208,000 h.p. secs, and three direct current generators each having an output of 1740kW, arranged for series operation and connected by bare copper busbars to the main mill motor. The set runs at 600 r.p.m. synchronous speed, the three generators together having a peak output of 10,650A at 1362V.

Alongside the Ilgner set is an exciter set for supplying the main mill motor field, and the variable voltage generator fields of the Ilgner set. The exciter set is driven by a 125 h.p. 3300V, 3-phase, 50 c/s synchronous motor at 1000 r.p.m.

The motor takes sufficient leading kVA to correct the power factor of the 5000 h.p. motor to 0·95 lagging. The manipulators are designed to operate at a speed of 137ft per minute, and are of the universal electrically-operated side guard type with all the actuating mechanism located on the main drive side of the mill.

The manipulator heads are operated by four 100 h.p. motors through a double reduction gear unit, pinions and racks. One manipulator head is fitted with four-finger tilting gear driven by an 80 h.p. motor through double reduction gear, crank drive, gears and rack. The tilting gear drive, which is connected to the manipulator rack drive to equalise the movement of the manipulator and the tilting gear rack, is permanently mounted on the foundations. The breast roller and first rollers at each side of the mill are friction driven through a reduction gear driven by a 40 h.p. motor, having independent drive.

The mill train consists of the main coupling of the universal slab type with totally-enclosed cast iron pinions housings in halves mounted on cast iron bedplates. Lubrication of the pinions is carried out from the main oil system. Hydraulic balancing is used for both the top roll and spindles. The roll housings are cast steel, the posts having a minimum cross sectional area of 450 square inches. The roll chocks are cast steel lined with white metal and with phosphor bronze inserts. The bearings are water cooled through the chocks. The screw down gear is operated by two 150 h.p. motors giving a lift of 220ft per minute. The total travel of the screws is 36in. The roll-changing gear is of the sledge type, rope hauled, through a 25 h.p. gearbox. As all the actuating mechanism of the manipulator is on the drive side of the mill, the roll changing sledge is entirely clear of obstruction.

The control pulpit is normally under the control of three men.

There is a deseaming machine which deseams hot blooms on all four sides to depths ranging from 1/32in to 1/4in, if necessary, depending upon the speed of the rack. It can simultaneously deseam the four sides of hot steel blooms of 5in to 10in square, and slabs 5in to 16in wide by 2in to 5in. The speed of the deseaming roller table is 100ft to 300ft per minute.

The bloom shears are of the Sack design, electrically driven up and down cutting, cutting up to 144 square inches and exerting a maximum blade pressure of 700 tons. (They have recently been described by J. A. Kilby in the *Journal* of the Iron and Steel Institute, 167, pp. 165 to 199, February, 1951.)

Scale disposal is by means of a closed system of water flushing through culverts under the roller tables and blooming mill housings. These connect to the scale pit and have sufficient fall to ensure a complete washdown of scale. Beneath the blooming mill housings, and below the bottom roll level, a grid is fixed for collection of scrap ends from ingots, &c. These are too large to wash down by water pressure, and are pulled off the grid, and put into a skip which is lowered below the grid level on the drive side of the mill. The scale culverts are also inspected and cleared of obstructions during meal stops. Flushing water is provided at the rate of 500 gallons per minute at 80ft head. The scale pit is common to both the blooming mill and the billet mill.

The billet and sheet bar mill is a six-stand 19in continuous mill. Two sets of roll housings are provided, one for billets and the other for sheet bar. The billet rolls have barrels 32in long, and the sheet bar roll barrels are 22½in long. The first four stands have rolls of 21in nominal diameter and the last two 19in diameter. The six stands are driven by a 4000 h.p. motor, running at 585 r.p.m., through a single reduction helical gearbox giving a reduction of 5·85 to 1 on to a common main shaft running at 100 r.p.m. The transmission to the six stands from the main shaft is by spiral bevels gears through pinion housings to each stand. The spiral bevel gears are arranged to give increasing speeds at each stand. The mill has a delivery speed of 600ft per minute, to conserve the temperature of thin sheet bar. When rolling sheet bar or slabs, there are two vertical edging mills in use. One in front of No. 1 stand and the other between Nos. 2 and 3 stands. These can be opened to pass billets through. The two edging mills are driven by two 125 h.p., 400 to 800 r.p.m. shunt wound, 5-hour rated mill type motors.

The roll housings are of steel and are equipped with Morgoil bearings lubricated by oil circulating system. The bearings are set up on the rolls in the roll lathe shop and transported to the mill in pairs, being placed conveniently for the mill crane to handle. The delivery guides begin the twist on the bar which is carried on and completed by the twist rollers. When rolling billets the bloom enters No. 1 stand and turns 90 deg. between stands 1 and 2, turns 45 deg. between stands 2 and 3, turns 90 deg. between stands 3 and 4, goes straight between stands 4 and 5 and turns 90 deg. between stands 5 and 6, leaving No. 6 stand as a square on edge. The same procedure applies when stands 5 and 6 are dummied and the billet is being finished in stand 4. The twist rollers can be withdrawn on beds hydraulically when changing over to sheet or sheet bar or slabs.

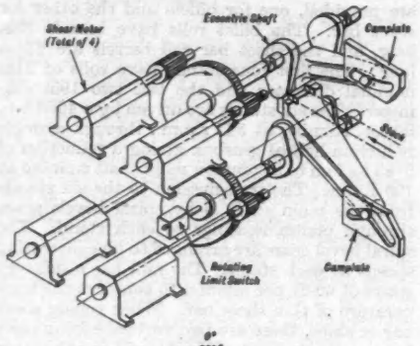
The same spindles are used for connecting up billet and sheet bar sets of roll housings, although the sheet bar rolls are 10in shorter. To keep the driving faces in approximately the same position in the roll and wobbler boxes, cast iron blocks are inserted behind the spindles in the driving coupling boxes when the sheet bar housings are in use.

* Conference, June 13th and 14th. Plant Engineering Division of B.I.S.R.A.

† Paper by J. Peacock.

The set of housings not in use is made up and rolls are mounted close to the mill. The housings are interchanged one by one. To mount the rolls, a special rig attached to the crane hook picks up the roll by the wobbler, complete with Morgoil bearings, and puts the roll into position in the housing. The electric flying billet shear is the first of its kind to be installed in this country. It is the largest yet built, with a capacity of 16 square inches cross sectional area, either 4in by 4in or 16in by 1in. The function of the shear is to crop the front end and to continue to cut the billet or sheet bar into lengths pre-set by the operator. The range of length of cut is 15ft to 30ft. The speed of the shear is 250ft to 628ft per minute. It consists essentially of two blades each mounted on a crank, Fig. 2. To each crank is attached a tail rod, at the rear end of which is a roller guided by a specially designed groove in a fixed cam plate. This permits parallel operation of the blades during the cutting part of the cycle.

A roller table driven by a variable speed motor delivers the billet from the mill to the shear. Just beyond stand 16 is located a flag switch for automatically starting and stopping the shear. A measuring roll is located between stand No. 6 and the shear, and measures the speed of the billet or sheet bar, regardless of whether the material is being delivered out of stands Nos. 4, 5 or 6. The shear makes a cut every revolution, and has a 9ft blade circle.



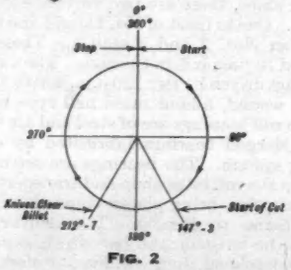


FIG. 2

The length of cut is controlled by slowing down the shear just as the blades clear the billet, and then reaccelerating it to billet speed for the shear blades to engage the billet for the cut. Cuts for two lengths for 630ft per minute billet speed are illustrated in the diagram, Fig. 3.

Discussion

The roller twist guides on this mill came in for comment. Mr. E. Rhys Jones (Guest Keen Baldwins Iron and Steel Company, Ltd.), claimed that they could give up to 20 per cent increase in roll life, and Mr. W. Udall emphasised that, in addition, they had a lower power consumption than static guides. He had seen no satisfactory figures on which comparison could be based between roller twist guides and horizontal/vertical mill stands. Mr. F. B. George (Consett Iron Company, Ltd.), pointed out that Bedson's original design had been for a combination of vertical and horizontal rolls, but the then state of mechanical engineering had not made this possible and twist guides had been substituted. The next logical step appeared to be "back to Bedson."

Mr. T. W. Hood (United Steel Companies, Ltd.), asked whether he was not correct in

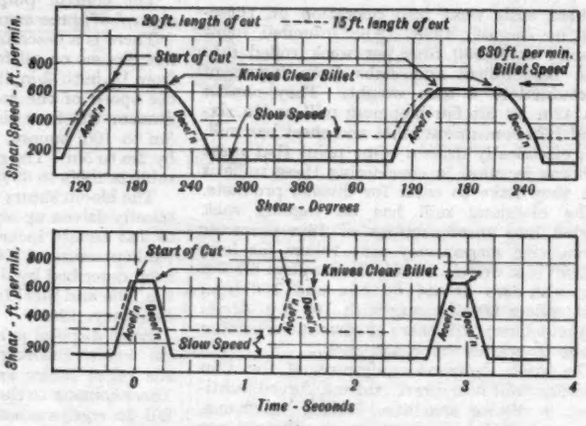


FIG. 3

assuming that as the billet mill was also required to roll a considerable proportion of flat products, such as sheet bar, it was necessary for most of the rolls to be horizontal, and that a mill with alternately vertical and horizontal stands would not be suitable for their requirements.

Mr. P. M. Miln said that non-ferrous metal rolling mills using horizontal/vertical stands seemed to him to look like a designers dream, but a maintenance man's nightmare.

Mr. F. B. George briefly described the new billet mill which was being installed at Consett, which he hoped would be in operation within a few months. It was to be a combined slabbing and blooming mill, handling a maximum weight of 20-ton ingots. A two-high twin motor slabbing mill was to be followed by ten stands of alternate vertical and horizontal stands each individually driven by 1250 h.p. motors. Billets were to be delivered to a hot saw or to an electric shear similar to that described by Mr. Peacock.

Several speakers mentioned the advantages of fabric bearings, to which Mr. Peacock replied that the water available to them was not clean enough, although this might be corrected in the future. Mr. W. Craig thought that the Morgoil would hold its own with any other system.

Mr. R. Stewartson liked the fact that the soaking pit covers were operated by the crane man. At the Steelton Plant of the Bethlehem Steel Co. in the United States, the crane man could also operate the ingot buggy and such factors as these enabled that modern soaking pit installation of sixteen holes to be worked by only four men on the pit floor.

Mr. W. Bailey said that his firm, too, were using cartridge type bearings in roller frames, which saved cost and time in location.

A suggestion from Mr. W. Craig that works in this country should substitute for a dial at the rolls an indicator clock in the pulpit, as was the practice in the United States, met with little favour. Although such a clock could eliminate obscuration by steam and vibration and backlash, Mr. A. H. Norris (John Lysaght, Ltd.), thought that it was essential to have the clock over the cogging housing, as the cogger had to keep his eye on the bar being rolled as well as the clock. Also, the other operators could not only see when the screwdown was complete, but also they could learn the draftings themselves. Mr. H. H. Mardon (British Iron and Steel Research Association) thought that another disadvantage might be the necessary quick change of focus by the cogger in looking from the roller rack to the clock in the pulpit, a point with which Mr. Udall strongly agreed, emphasising that it was also necessary for the operator to keep his stock in sight.

(To be continued)

A Propeller-Turbine Brake

We have recently received details of an engine brake for use on propeller turbines. This unit has been jointly developed by Armstrong Siddeley Motors, Ltd., and the Lockheed Hydraulic Brake Company Ltd., The "run down" time of propeller turbines, which often takes about 40 seconds, has greatly extended the normal time taken to stow naval aircraft below decks. With this brake unit fitted the propellers can be fully stopped within 15 seconds.

The brakes themselves are constructed of light alloy and operate on the principle of the

Propeller Turbine Brake

standard Lockheed hydraulic car brakes, but are of the trailing shoe type. Two cylinders, varying in size with the brake, give the normal expansion to the shoes, with two powerful pull-off springs ensuring the return to the "off" position. The shoe linings are of a material suitable for use when immersed in oil at high temperatures, these conditions having presented the major difficulty.

Upon the isolation of the engine, the propeller feathering hydraulic system "feathers" the propeller and is made to generate a pressure sufficient to operate the brake unit, which is assembled inside the propeller gear box.

Also included in this system is an accumulator, which enables the brake to remain "on" in a parked aircraft, or on a "feathered" engine during flight. The desirability of the accumulator becomes apparent when it is realised that wind speeds, particularly on an aircraft carrier, can spin the propeller of a free turbo-propeller engine, so becoming a danger to personnel and, in the case of a feathered engine in flight, the propeller is thus prevented from spinning in either direction.

When space limits the size of the brake unit employed, a pressure intensifier can be employed.

A Trigonometrical Indicator

A circular trigonometrical indicator has been devised by the Andremath Computor Company, Birmingham. The unit consists of three plastic circular discs pivoted at their centres, the central member being a complete disc, whilst the top and bottom discs are partly cut away to act independently as rotating cursors. On each side of the central disc the sin, cosine, tangent and reciprocal trigonometric ratios of angles from 0 deg. to 90 deg. are marked. These ratios are marked in concentric rings about the pivot, each ring being confined to a particular function, which is indicated on the cursors. The indexing profile of the cursor is such that if any of the six trigonometrical (four and five figure) ratios are known, the angle (5′ intervals) can be read off, and conversely if the angle is known. Simple instructions, together with elementary formulæ, are marked on the discs.

Induced Draught Cooling Towers in Germany*

INDUCED draught cooling towers have been in use for some time in German power stations and are now under consideration for pithead generating plant. German engineers claim that the induced draught design has the advantage of lower first cost, requires less space and, being capable of cooling through a wider range than a natural draught tower, enables condensing plant to be operated with only 50 per cent of the water throughput required with natural draught. The cost of pipe-lines and cooling water pumps is also reduced. Comparison of performance seems to show that the reduced power required for pumping compensates for the power required for the ventilating fans.

Comparison of Natural Draught and Fan Cooling Towers. German Data. Price Basis 1943.

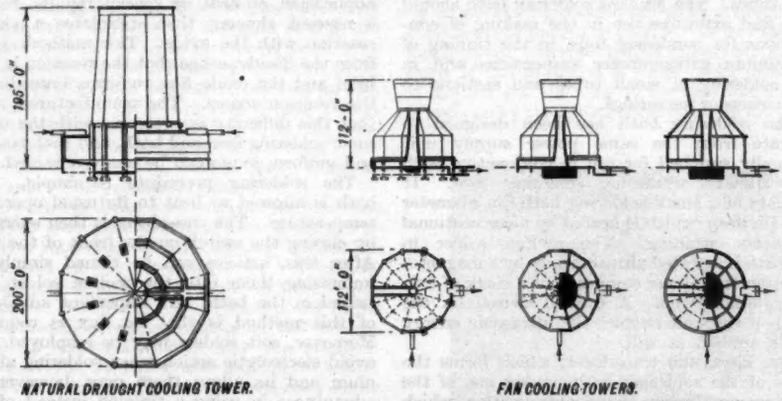
	Natural draught cooling tower		Fan cooling tower		
Foundation	Normal	Strengthened	Normal	Strengthened	Strengthened
Material for main structure	Steel and wood	Steel and wood	Steel and wood	Steel and wood	Concrete
Cost of Construction :	£	£	£	£	£
Foundation and base	13,800	29,000	8,300	16,600	16,600
Upper part	8,300	8,300	2,850	2,850	8,300
Internal and Mechanical parts	15,000	15,000	14,000	14,000	14,000
Total	31,100	52,300	25,150	33,450	38,900
Materials and labour:					
Cement	510 tons	800 tons	307 tons	707 tons	835 tons
Aggregate and sand	3,600 tons	6,000 tons	2,025 tons	4,540 tons	5,250 tons
Steel (total)	254 tons	325 tons	162 tons	326 tons	315 tons
Wood built in	25,000 cubic feet	250,000 cubic feet	17,000 cubic feet	17,000 cubic feet	14,000 cubic feet
Labour	14,000 manshifts	19,600 manshifts	9,375 manshifts	12,475 manshifts	12,600 manshifts
Steel required for cooling water mains (one station, 6×32 MW)	1850 tons		800 tons		
Capacity	180 million B.Th.U. per hour		180 million B.Th.U. per hour		
Water throughput ...	1,760,000 gallons per hour		880,000 gallons per hour		
Cooling zone temperature	88–77 deg. Fah.		90–68 deg. Fah.		

Induced draught cooling towers are built very much like the venturi tube cooling towers known in this country. At the narrowest point of the throat there is a horizontal propeller fan rotating at about 90 r.p.m. at normal load. The vertical fan shaft passes through a concrete casing leading to a gear located in the foundation of the tower. The speed of the fan is controlled by a thermostat, the thermostat itself being controlled by the cold water temperature. This automatically results in a reduction of the speed of the fan at lower ambient temperatures. Cooling towers of this type are under construction at the pithead stations Mengede and Hamborn of the Gelsenkirchener Verein.

A comparison between the different types of cooling tower for a turbo-generator of 32MW is shown in the illustration. At full load the natural draught cooling tower pump has a power consumption of 570kW compared with about 310kW for the pump required by the fan-driven cooling tower. To the latter must be added 280kW required for the fan drive. At full load the power required for operating the fan-driven cooling tower is therefore 590kW or 20kW higher than that required by the pump operating with the natural draught cooling tower. For weather conditions obtaining in Germany it is assumed that the fan is required only during about 60 per cent of the time the tower is in operation, as with low ambient temperatures the cooling effect can be obtained with the fan idle. German engineers assume that, as a result, 170kW can be assumed to be a fair yearly average power consumption of the fan. When this is added to the 310kW power required for the pump, the total power requirements for pump and fan for the fan-driven cooling tower amount to 480kW, which is approximately 16 per cent less than the power required by the pump working with the natural draught cooling tower.

German engineers admit that the carry-over from the fan-driven cooling tower is higher than that of a natural draught cooling tower, which can be a considerable nuisance to the surroundings, especially in winter time. Furthermore, in case of water shortage, the greater amount of make-up water required can be a serious disadvantage. Owing to the lack of sufficient operating experience, no figures about the actual amount of make-up could be obtained.

The costs given in the table above relate to the erection of cooling towers in Germany and should be used only as a means of comparing the cost of the two types of tower in that country. The cost in Great Britain of the two types of tower will not correspond with the figures given for Germany and will not necessarily be in the same proportion.



NATURAL DRAUGHT COOLING TOWER. FAN COOLING TOWERS.

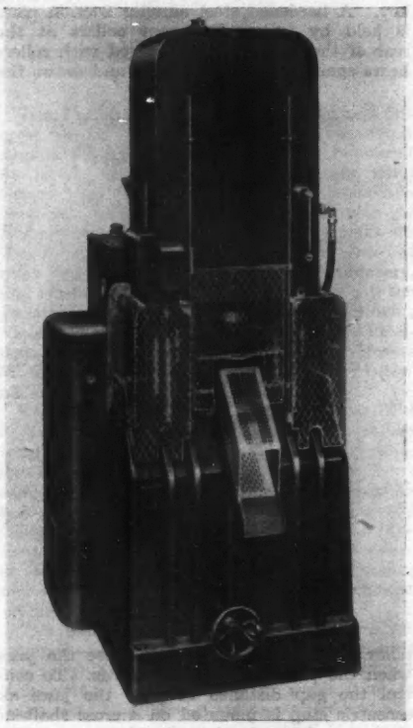
COMPARISON OF NATURAL AND INDUCED DRAUGHT COOLING TOWERS

* National Coal Board Production Department, Information Bulletin No. EG (51) 8, based on a visit to Germany by B. L. Metcalf, R. M. Marson and F. B. Karthauser, in August, 1950.

An Automatic Hydraulic Preforming Press

IN order to meet a demand for a preforming press to produce the larger pellets now called for by the steadily increasing size of thermosetting mouldings, T. H. and J. Daniels, Ltd., Stroud, Glos, has introduced a machine for producing tablets weighing up to 6 lb. On this machine, which is illustrated herewith, there can be made any shape of tablet which can be contained in a 6in diameter circle. It has a maximum depth of fill of 6in, and incorporates a core pin carrier by which tablets with a central hole can be produced.

The machine is hydraulically-operated and is designed to exert a maximum pressure of 125 tons. It is fully automatic and when required can be set for single cycle working where hand filling of awkward materials is desired. A modified design of the makers' process controller is fitted and it is interlocked so that the main ram cannot come down until the powder slipper has been withdrawn. When a tablet is being formed in the machine, pressure is applied at both the top and the bottom in such a way that the lower part will remain firm and not crumble on removal. Within certain limits, the pressures on each side of the tablet can be varied independently.



HYDRAULIC PREFORMING PRESS

The lower part of the press is enclosed within a rigid cast iron base and the sides are fitted with easily removable covers giving access for inspection and maintenance. A fully-floating main cylinder is arranged to rise as the top punch begins to press the tablet. As the cylinder rises it draws up the bottom crosshead through four columns to compress the tablet from the bottom. A double acting main ram is used together with a pre-filling ram to give a rapid approach speed.

The pump unit is driven by a 15 h.p. motor, and is mounted in an enclosure at the rear of the machine. A powder feeding hopper, which holds about 1 cwt of material, feeds the die through a sliding shoe operated by a double-acting hydraulic cylinder. Tablet depth and weight is adjusted by means of a handwheel at

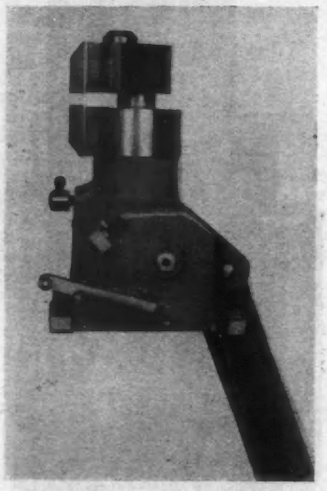
the front of the machine and the pressure is controlled by a valve set adjacent to a pressure gauge.

The makers state that up to three tablets of the maximum possible size can be produced per minute on this machine.

A Small Foot-Operated Press

A USEFUL foot-operated press, suitable for light assembly work on small component production, is now being made by Caledonian Works, Princes End, Tipton, Staffs. The unit consists essentially of a press head, which is suitable for bench or pedestal mounting and having vertically or horizontally mounted jaws. The pedal has a movement of about 9in and through the connecting links it gives a leverage ratio of 24 to 1. A maximum jaw movement of $\frac{1}{16}$in is obtainable.

One of the bench-mounted units is illustrated below. The movable jaw is carried on a substantial steel pillar, which can slide on the head and is kept in alignment by a long key. A hardened steel annular friction plate is held by wear adjustment collars at the rear of the pillar. A yoke fitted with rollers bears against the friction plate and draws the



PRESS HEAD

pillar down into the head to close the jaws when the pedal is pushed forwards. To control the gap distance between the jaws an eccentric stop is mounted on a cross shaft at the rear of the head, and this stop can be turned by means of a short hand lever to set the gap or vary it between working strokes.

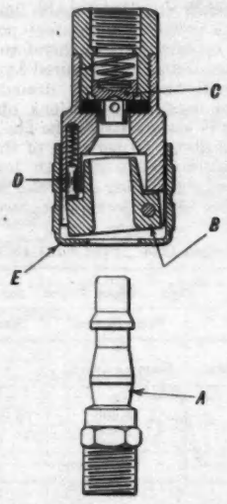
As the jaws project beyond the side of the head the machine can be used for dealing with long strips of material that call for pressing operations at intervals along their length.

Specially shaped jaws enable the press to be used for shearing, notching, dimpling, piercing, rivet closing and clinching. It may also be used as a sensitive foot-operated parallel action vice for holding components for small soldering or welding operations.

A Quick-Action Air-Line Coupling

WE have received from Pneumatic Components, Ltd., of Eyre Street, Sheffield, a specimen of a simple yet effective quick-action air-line coupling, which the company is now manufacturing. The arrangement and method of operation of the coupling can be seen from the drawing we reproduce herewith.

When a secondary air hose serving a tool or appliance is being connected to the main air-line the adapter *A* fixed on the end of the hose is inserted in the coupling head. The adapter first passes through the hinged detent body *B* and, as its leading end registers in the main bore of the body, raises the detent. With continued pressure the head of the adapter pushes back the spring-loaded valve *C* and, at the point where the ports of the valve are open to the compressed air in the line, the detent is swung down by a spring-loaded plunger *D*. The detent registers behind the collar of the adapter and holds it firmly in engagement with



AIR-LINE COUPLING AND ADAPTOR

the main body of the coupling with the compressed air flowing freely past the valve into the second air-line.

When it is required to remove the second air line the outer sleeve *E* of the body is pushed back and this action raises the detent to free the adapter. As the adapter emerges from the body the valve moves forward to seal on its rubber seating and the air ports are closed.

An Ultrasonic Soldering Bath

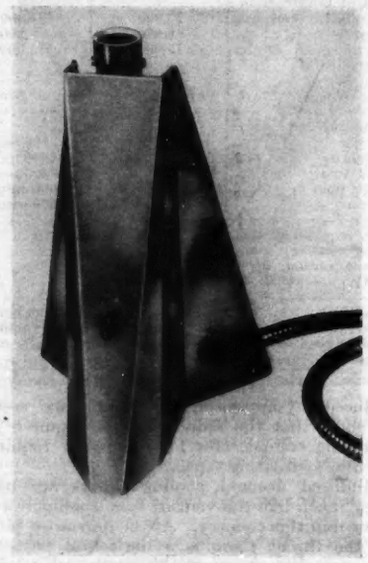
THE rapid tinning of small aluminium and aluminium alloy articles is made possible by an ultrasonic soldering bath recently introduced by Mullard, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. This unit has been specifically developed by the company's equipment division for the soldering of small and complex shaped parts which cannot easily be handled by the Mullard ultrasonic soldering iron. Included in this category of work are such items as foils, wire and tubes. The Mullard soldering bath should also find extensive use in the making of connections for condenser foils, in the tinning of aluminium galvanometer suspensions and in the soldering of small tubes and sections to anchorings or mountings.

The soldering bath has been designed to operate from the same power supply unit normally supplied for use in conjunction with the Mullard ultrasonic soldering iron. It consists of a small soldering bath $\frac{3}{4}$in diameter and $\frac{3}{4}$in deep, which is heated by a conventional resistance winding. The molten solder in the bath is agitated ultrasonically by a magnetostriction transducer composed of a stack of iron alloy laminations. A control switch on the front of the unit enables the ultrasonic energy to be applied at will.

The ultrasonic transducer, which forms the basis of the soldering bath, makes use of the phenomenon known as magnetostriction, which relates to the small dimensional changes that occur in ferro-magnetic materials when they are placed in a magnetic field. These changes are very small; even in nickel, which is one of the most magnetostrictive materials available, the greatest change per unit length is only about thirty parts in 1 million. To obtain the maximum efficiency of operation it is necessary to excite the system at its natural resonant frequency. In the case of the transducer used in the Mullard ultrasonic soldering iron and bath this frequency varies between about 19·5kc/s and 21kc/s, according to the temperature and the intensity of the magnetic field. This frequency band is well above the normal audible range, so that no discomfort is experienced by the operator.

The principle of operation of the equipment is that, when the electronic amplifier is switched on, a surge of current is applied to the main excitation coil of the transducer. This gives rise to a change in the magnetic field in the magnetostrictive element and hence in the length of the transducer. This change in length induces a voltage in the pick-up coil, which is fed back to the amplifier, thus enabling oscillations to be sustained at the natural frequency of the magnetostrictive element, irrespective of any temperature changes which may occur. The use of high impedance coils eliminates the necessity of using transformers for coupling and simplifies the amplifier circuit and reduces weight.

In the new soldering unit the rapid vibration of the bath, resulting from the magnetostriction effect produced in the transducer, is used to break up the highly refractory oxide films which normally form very easily on such metals as aluminium. In the past, one of the few effective ways of removing these films has been through the use of fluxes, which, on the



ULTRASONIC SOLDERING BATH

application of heat or special liquids, release a nascent element that stimulates a violent reaction with the oxide. This method suffers from the disadvantage that the reaction is only brief and the oxide film re-forms immediately the reaction ceases. The manufacturers state that this difficulty is overcome with the ultrasonic soldering iron and bath, and that positive and uniform joints can be easily obtained.

The soldering procedure is simple. The bath is allowed to heat to its usual operating temperature. The transducer is then energised by closing the switch on the front of the unit. After this, articles can be tinned simply by immersing them into the molten solder contained in the bath. An important advantage of this method is that no flux is required. Moreover, soft solders may be employed. To avoid electrolytic action when soldering aluminium and its alloys there may, however, be advantages in using a tin-zinc instead of the usual solder with a tin-lead base.

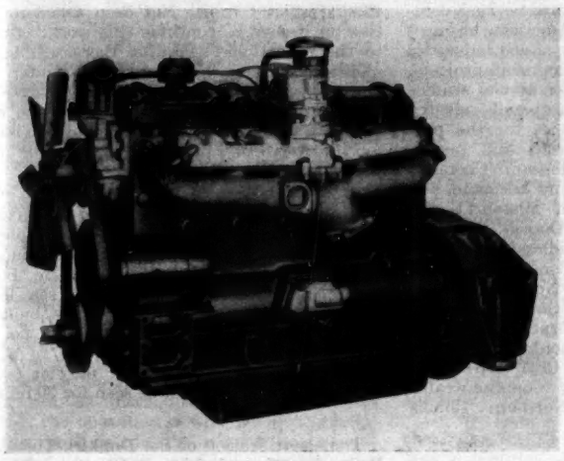
The ultrasonic power necessary to drive the transducer is supplied by an electronic amplifier comprising the power supply unit. This unit is housed in a metal case with handles and may easily be carried around the factory. It is suitable for operation from 100–250V, 40–60 c/s mains supplies and has a total power consumption of about 200W. Connection with the soldering bath is by a simple multicore cable, which supplies both the heating winding and the transducer excitation and pick-up coils. The only control on the supply unit is the amplifier switch.

The dimensions and weights of the units comprising the equipment are as follows: soldering bath, 6in by 6in by 9$\frac{1}{2}$in and 4 lb; supply unit, 9in by 10in by 12in and 40 lb.

An Improved Commercial Vehicle

We have recently received details of several alterations to the "Superpoise" range of commercial vehicles made by Commer Cars, Ltd., Luton.

All models are now to be fitted with a vertical six-cylinder, overhead valve engine with a bore of 3¾in and a stroke of 4¼in., as shown in the accompanying illustration. This new engine develops 85 b.h.p. with a maximum torque of 200 lb/ft, which represents an increase respectively of 7 per cent and 14 per cent on the power characteristics of the six-cylinder underfloor engine used at present. The engine embodies improved combustion chambers and a rearranged manifold system, and a seven-bearing crankshaft with four integrally forged balance weights is now fitted. The pressure lubrication system has a capacity of 6½ gallons per minute at 3000 r.p.m. Within the cooling system a centrifugal pump is able to supply water directly to such "hot spots" as the exhaust ports and sparking plug bodies by means of a distribution pipe in the cylinder head.



SIX CYLINDER PETROL ENGINE

The "Girling" two-leading shoe brake has been retained but the shoe widths have been substantially increased in the case of 2/3 and 3/4-ton models, the liner area being greater by 41 per cent. In the 5-tonners, the front drum diameters have been increased from 14in by 2¼in to 16in by 2¼in, whilst the rear brakes change from 16in by 3in to 15¼in by 4¼in, the total liner area being increased by 32 per cent.

On the 3/4 and 5-ton, models 5¼in "Clayton-Dewandre" servo units are fitted.

The chassis frames have been strengthened and the side members have now a maximum section modulus on the smaller models of 6·78 and on the 5-tonner, 7·44. A carbon-manganese steel is used of 38–46 tons tensile strength. Because of the increased power rating other modifications have included the enlargement of universal joints and the strengthening of the propeller and axle drive shafts. On all models the new wide base rim road wheels have been adopted.

A Gust Alleviation Device for Aircraft

A gust alleviation device, developed by Boulton Paul Aircraft, Ltd., is now undergoing trials on a "Lancaster" aircraft.

In the Boulton Paul system an electro-manometric transducer mounted at the nose of an aircraft detects vertical components of gust pressures, termed gust signals, which require symmetrical displacements of the ailerons if level flight is to be maintained. After suitable amplification, the difference between the gust signal demand for aileron adjustment and the actual aileron position in relation to the gust is converted to a mechanical displacement. This operates on the input to a Boulton Paul electro-hydraulic power control unit and superimposes the required gust correction on the ailerons independently of the normal control by the pilot.

If adequate gust alleviation is to be achieved, the aileron correction must be applied at the instant at which the gust acts on the wing structure. It follows, therefore, that a suitable time delay is required between detection of the gust signal and operation of the ailerons to correct for the gust. The time required (of the order of $^1/_{10}$ second) is a function of the distance between the gust detecting device and the wings, and of aircraft speed. In the experimental installation, provision is made for varying the transmission time of the whole system in relation to dynamic air pressure, so that the behaviour of the aircraft may be studied under varying conditions of speed and transmission delay. Future gust alleviation systems will probably incorporate automatic transmission delay correction to compensate for variations in air speed.

A Large Boring Machine

The photograph we reproduce below shows a large horizontal boring machine designed and built by H. W. Keerns and Co., Ltd., of Broadheath, near Manchester, for the machining of large diesel engine units at the Colchester works of Davey Paxman and Co., Ltd. This machine has a particularly large table for which a special means of support has been introduced. The main table is 5ft wide by 16ft long, and has a transverse traverse of 14ft 6in on the 20ft long saddle. In order to reduce to a minimum the deflection of the table in the transverse direction, the bed width is increased to 15ft by means of a rigid extension on each side of the machine to support the saddle over its effective longitudinal traverse length. Parallel movement of the saddle in a longitudinal direction is ensured and the load on the feed mechanism is reduced by the fitting of ball bearing mounted rollers on the saddle. These bearings run on the outer bedway supports to be seen in the illustration. A 6ft by 7ft revolving table is mounted on the main table of the machine.

The machine is driven by a 25 h.p. motor controlled by remote pendant gear and is fitted with a 6in diameter drilling and boring spindle, the slide of which has a vertical traverse of 5ft on the column. This spindle has twenty-four speeds, from 2·3 to 160 r.p.m., and can be traversed 2ft 6in at one or 5ft at two settings. A built-in facing chuck has a machining diameter of 54in and has a similar range of speeds to the spindle. Two boring stays on the machine are each designed to take an 8in diameter bar. The maximum distance between the facing slide and the outer boring stay is 17ft 6in, and the maximum distance the spindle centre can be set above the main table is 5ft 8½in.

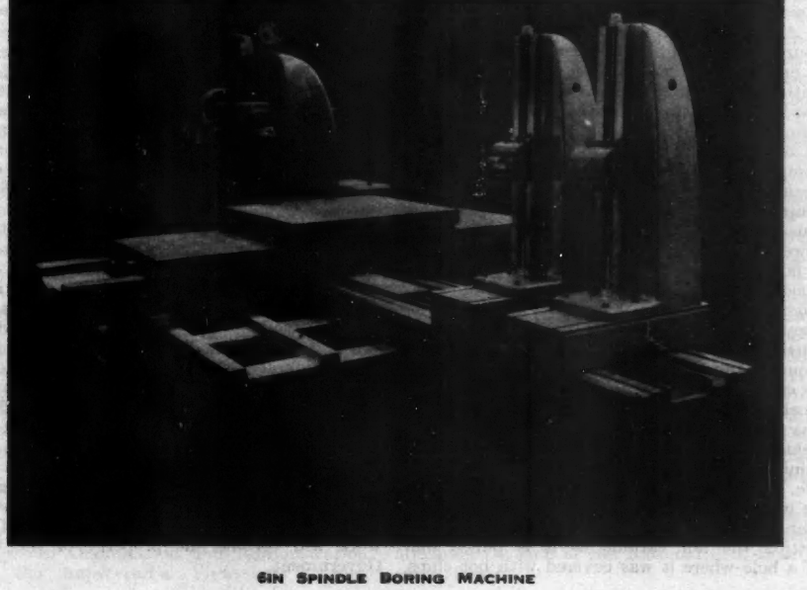
Two ranges of eight feeds are available for the facing slide travelling spindle, vertical, transverse and longitudinal traverses. In one range, 8 to 96 cuts per inch are made and in the other the traverse is 0·4in to 5in per minute.

International Refrigeration Congress

The Eighth International Refrigeration Congress, which will be held in London, from August 29th to September 11th, is honoured by having as its patron His Majesty King George VI. The Congress will be held under the auspices of the International Institute of Refrigeration (L'Institut International du Froid) which numbers the Governments of more than fifty countries among its members, and this year's event is being organised by the Institute of Refrigeration under its President, Viscount Bruce of Melbourne, who is also President of the Congress, together with Professor W. J. de Haas, as representative of the International Institute.

The last assembly in this country was held in 1924, when one hundred and sixty papers were read and discussed, but for the forthcoming meetings the number of papers has been limited so that discussion may be confined to the principal subjects. Those attending the Congress will represent many branches of the food industry and manufacturing industries, in which mechanical cooling is a process necessary for first-class production or efficient manufacture.

The subjects dealt with in the papers are grouped under seven commissions, among which the freezing and chilling of foods figure prominently, as it is with the application of improved methods of refrigeration in this direction that the world seeks relief from post-war difficulties in food supply.



6IN SPINDLE BORING MACHINE

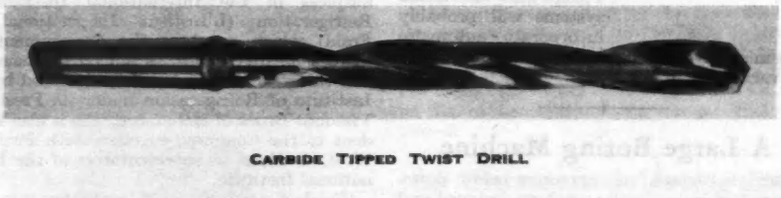
A full and interesting programme of excursions and industrial visits is arranged. Organisation of parties is already proceeding and intending members can obtain particulars from the Secretary, Eighth International Congress of Refrigeration, Dalmeny House, Monument Street, London, E.C.3.

American Engineering News

(From our American Correspondent)

Carbide Tipped Twist Drills

The accompanying illustration shows a carbide-tipped twist drill, which has been made by inserting and brazing a "Carboloy" carbide tip at the end of a conventional high-speed twist drill. Good results have now been obtained by an American manufacturer of twist drills by brazing such carbide tips to the ends of standard high-speed steel twist drill bodies as a regular manufacturing operation. The conventional 118 deg. point angle is ground on the end of the drill at a 12 deg. lip relief angle by using a 180-grit resinoid bond diamond cup wheel. It has been found advisable to remove first the excess steel and carbide with a silicon carbide wheel by grinding a 14 deg. clearance angle up to a $^{1}/_{32}$in wide land. Longest drill life has been



CARBIDE TIPPED TWIST DRILL

obtained when the cutting edges along the drill lip were smooth and keen and without blemishes. The length of the drill lips has been kept identical and to facilitate a free flow of chips, the drill flutes were polished. A silver brazing alloy, such as "Easy-Flo No. 3," has been used as a brazing material. An 8 deg. right-hand spiral at the drill lip increased to a 15 deg. right-hand spiral for the flutes through the drill body, has resulted in a free movement of chips along the drill. In general, if the drilling machinery permits, the following conditions are recommended for the drilling of cast iron with carbide-tipped twist drills :—

Speed.—Twice that for high-speed steel twist drills.

Feed.—Same amount per revolution as with high-speed steel drills.

Rate of Penetration.—Twice that with high-speed steel drills.

Average Tool Life.—Expectancy : three to four times that of high-speed steel twist drills.

Speeds as high as 200 surface feet per minute with 0·013in feed per revolution have been used while drilling $\frac{13}{16}$in diameter holes up to 5$\frac{1}{2}$in deep from the solid, without any sign of breakdown of the braze from the increased temperature developed by the longer drilling period and the greater accumulation of hot chips. For drilling holes much deeper than this it might be advisable to use somewhat lower cutting speeds. Drill feeds between 0·008in and 0·013in per revolution have given good operating conditions in a variety of cases. Lighter feeds are not usually advisable, as they seem to contribute at times to an erratic cutting action, evidenced by objectionable vibration or "sing." Such vibration has tended to encourage a breakdown of the drill. Practically all drilling of cast iron parts to date has been done dry, since this practice has held the range of temperature fluctuation to a minimum, thus contributing to longer drill life. In those cases where a coolant had to be used, a soluble oil solution was found satisfactory. However, the shock due to the coolant hitting the hot carbide as it is pulled out of a hole where it was covered with hot chips may reduce the number of holes per grind as well as shorten the drill life. Under such conditions, operating the drill in the lower portion of the carbide drill speed-range has resulted in a lowering of the cutting temperature and a lengthening of the drill life.

Study of Industrial Nuclear Reactors

The Atomic Energy Commission has announced that negotiations are nearing completion with four groups of American business and industrial firms for an expanded industrial participation in reactor development projects. The four proposals provide for special studies of the practicability of business and industry building and operating reactors for the production of fissionable materials and power. They were submitted by the Monsanto Chemical Company, of St. Louis, and its associate, the Union Electric Company, of Missouri; the Detroit Edison Company, of Detroit; and the Dow Chemical Company, of Midland, Michigan; the Commonwealth Edison Company and the Public Service Company, of Northern Illinois of Chicago; and the Pacific Gas and Electric Company and the Bechtel Corporation of San Francisco, California. Agreements have already been signed with the Dow Chemical-Detroit Edison group and with the Commonwealth Edison-Public Service of Northern Illinois group. Consideration by the Commission of additional proposals will be postponed for the time being, since it is felt that four study projects is the maximum that can be carried on simultaneously in view of the demand which will be placed on technical personnel of the Atomic Energy Commission and its laboratories and contractors. The two laboratories principally concerned are the Argonne National Laboratory at Chicago and the Oak Ridge National Laboratory at Oak Ridge, Tennessee, both of which have heavy development programmes of high importance to the national defence. In general, the terms of the agreements executed with the Dow Chemical-Detroit Edison group and with the Commonwealth Edison-Public Service of Northern Illinois group provide that the companies will make a survey and study of the Commission's reactor development activities: (1) to determine the engineering feasibility of designing, constructing, and operating a materials and power producing reactor; (2) to examine the economic and technical aspects of building this reactor in the next few years; (3) to determine the research and development work needed, if any, before such a reactor project can be undertaken; and (4) to offer recommendations in a report to the Commission concerning such a reactor project and the role of industry in undertaking it and carrying it out. The maximum time permitted for the study is twelve months after signing of the agreement. All costs will be borne by the companies concerned with the exception of those costs incidental to making information and consultative services available by the Commission and its contractors. The distribution of the final report submitted on the project will be determined by the Commission. The Atomic Energy Commission will grant security clearances after certain investigations for a sufficient number of company staff to carry out the study. The number of such persons who will have access to reactor installations and consultants will be limited to fifteen. All inventions and discoveries made in the course of the work will become the property of the U.S. Government.

French Engineering News

(From our French Correspondent)

Credits for the modernisation of the gas industry for 1951 amount to 7 milliard francs, which means that there will be a general slowing down of the work now in progress and no possibility of starting any new construction. Up to now, 60 out of the 126 obsolete gas works covered by the modernisation plan have been abandoned in favour of more economical plants; 13,851 milliard francs had been asked for by Gaz de France to continue this work. Owing to the reduction in credits, there will be no question of a drop in cost price this winter, and it is possible that pressure will have to be reduced in winters to come. Also, the construction of most of the trunk mains envisaged for the North of France will have to be postponed.

* * *

The Ras-Bir lighthouse, situated on the coast of North Africa, has recently been completed. Constructed in a desert zone, it has been founded on madrepore, a kind of coral, 3m below the ground level and 30m above sea level. Its total height is 51m and it is built of reinforced concrete. A platform, 6m in diameter, carries the lantern, access to which is by a reinforced concrete interior spiral stairway. The beam can be seen for 30 miles.

* * *

The electrification of the Dunkirk-Thionville Railway and the linking of Dunkirk with the Rühr basin is now being studied by the S.N.C.F. and the German railways.

* * *

The development of the Port of Abidjan will be an important asset to the Ivory Coast, which is one of the most prosperous colonies of French West Africa. Plans for linking the port directly with the sea were formulated some time ago and the construction of a wharf at Port-Bouet, 410m long and 12·75m wide, supported by steel screw piles and equipped with ten 5-ton to 20-ton cranes, was undertaken. The wharf can deal with 600 tons of cargo each day, but this capacity became insufficient during the last few years. In 1948 export trade reached 223,500 tons and imports 107,400 tons, making 1100 tons per working day.

For some time the possibility of making Abidjan a deep sea port by piercing the barrier separating the lagoon from the sea was considered. Unfortunately, the first attempt at excavating a canal failed, due to its insufficient width and the inadequate length of the protecting dyke.

A second attempt was then undertaken in a new area 3km west of the site of the first canal and the proposed work was extended to include flood protection of the town of Abidjan. Ultimately the plan is intended to cover the construction of a canal across the coastal cordon; establishment of sea defence berms of earthwork faced with stone; the construction of two breakwaters protecting the sea outlet of the canal and other protective works. The canal will be about 2700m long and 370m wide at sea level. The width is reduced to 250m, however, at a distance of 500m from the sea. At the sea outlet the depth of the canal is 20m. The canal banks have been covered, up to water level, by a facing of 600kg of rock per square metre, which reduces the canal cross section by about half, and the ebb tide will reach a velocity of 2m a second instead of 1·20m a second, thus giving the current needed to avoid silting.

The Port of Abidjan will be reconstructed when the above work is completed. It will include a 2km long strip of ground with a coal and wood quay along 300m. There will then be two berths, one 125m long and the second 450m long. A banana loading quay will also be constructed with a length of 125m, giving a total length of quays in the first stage of 1000m.

A number of dockside sheds will also be built and a 25,000 square metre stocking area will be set up behind the quay.

Industrial and Labour Notes

Metal Allocation Schemes

On Thursday of last week the Chancellor of the Exchequer, Mr. Hugh Gaitskell, announced measures on which the Government has decided for controlling the use of scarce metals. He dealt first of all with steel, saying that, though production was not likely to be seriously below last year's record level, demand was rising, and this year's total requirements were likely to exceed available supplies. Allocation schemes, the Chancellor stated, were being prepared for iron and steel (in addition to sheet steel and tinplate, which are already allocated) for introduction as soon as possible. Corresponding measures to regulate the distribution of the more important of the scarce non-ferrous metals would also be worked out. But as it would take some time to get those introduced and working effectively, interim measures would be brought into operation to safeguard the defence programme.

These interim measures are as follows: a "Defence Order" symbol will be applied, by Government decision, to orders for specialised defence equipment or work. Such contracts will be distinguished by the letters "D.O.", the quotation of which, with the order number, will entitle the contractor or subcontractor to obtain steel and certain non-ferrous metals. At this stage the latter will be limited to copper and zinc and their alloys. Contractors are to be notified in writing as to the contracts to which this D.O. rating will apply. So that the demands supported by a D.O. symbol are not unduly concentrated on particular suppliers, the Minister of Supply is arranging, through his steel rearmament panel and the British Non-Ferrous Metals Federation, for suppliers to set aside a proportion of their output for these special orders.

There are also proposals for safeguarding various categories of civilian production, while the allocation schemes are being worked out. These categories include dollar and sterling area exports and the fuel and power programmes. Arrangements are being made for the sponsoring Government departments to claim preferential treatment for specific orders for goods for which iron and steel and copper and zinc and their alloys are required, subject to a strict limit on the amount qualifying for such preferential treatment in any particular period. For this scheme the symbol "P.T.," indicating "Preferential Treatment," will be used. The scheme will be administered by all production departments, it being stated that it will enable them to deal with particularly difficult obstacles to important production caused by lack of comparatively small amounts of raw material. It is emphasised that the interim measures for civilian production are intended to apply only to a small number of cases of particular importance or difficulty.

Miners' Wages and the Coal Situation

The annual conference of the National Union of Mineworkers is being held at Blackpool this week. Resolutions on wages which have been submitted include one suggesting a demand for a minimum weekly wage of £7 10s. for underground workers, with corresponding adjustments for other grades. The union executive, however, has recommended to the conference that a cost-of-living bonus, based on the interim index of retail prices, should be be sought.

During his presidential address to the conference on Monday, Sir William Lawther said that the question of production, wages and prices must be overcome by increased productivity.

The Minister of Fuel and Power has expressed concern to the conference about the present rate of coal production. Recently, output per man-shift has been declining and production during June was nearly 250,000 tons below that in June last year. It will be recalled that, some weeks ago, agreement was reached between the union and the Coal Board that Saturday working in the mines should be suspended from June until the end of August.

Early in the proceedings of the conference, it was stated that the union proposes to conduct an inquiry into the administration and efficiency of the National Coal Board. The investigating committee hopes to complete its task in time to report to the annual conference next year.

Interim Index of Industrial Production

The index number of industrial production (1946=100), which is prepared by the Central Statistical Office, has been estimated provisionally at 151 for all industries in April, compared with a revised figure of 140 for March. Figures for the corresponding months last year were 135 for April and 144 for March. In making comparison, however, it should be borne in mind that the figures for March this year and April last year were affected by the Easter holiday. Taking the manufacturing industries only, the index figure for April this year was 158. For mining and quarrying, the figure was 127.

On the basis of information so far received, the index for all industries for the month of May is expected to be 146 or 147.

Trade Disputes

Stoppages of work through trade disputes, reported to the Ministry of Labour as beginning in May, numbered 169. There were also in progress twenty stoppages which had begun earlier. The Ministry of Labour says that, during May, 57,700 workpeople were involved in these stoppages with a consequent aggregate loss of 190,000 working days. In the five months January to May this year, 736 stoppages of work through disputes were reported to the Ministry, affecting 180,000 workers and causing an estimated loss of 904,000 working days. In the corresponding period of last year there were 636 stoppages reported, involving 123,500 workers, and resulting in a loss of 493,000 working days.

Of the 162 stoppages of work through disputes, which ended during May, this year, seventy-one, directly involving 2200 workers, lasted not more than one day; forty-one, directly involving 6600 workers, lasted two days; seventeen, directly involving 1900 workers, lasted three days; eighteen, involving 4300 workers, lasted from four to six days, and fifteen, directly involving 6900 workers, lasted for more than six days.

Productivity and Engineering Wages

Speaking at the annual meeting of the national committee of the Amalgamated Engineering Union on Friday last, the Minister of Labour, Mr. Alfred Robens, expressed the view that this country was again facing a "potentially inflationary situation," the only real answer to which was a still further increase in productivity.

If productivity could be increased enough, the Minister said, provision could be made for the home market, the export market and the defence programme and yet enable wage increases to be granted which would not be inflationary but would represent improvements in real wages. To achieve that, he thought it was essential that the amount and timing of wage increases should still be the subject of careful consideration by the leaders of both sides of industry.

In the course of his speech, the Minister stated that the Government had no intention of introducing direction of labour at the present stage of the rearmament programme.

Industrial Organisation and Administration

The Institute of Industrial Supervisors has just published a booklet entitled "Industrial Organisation and Administration from the Supervisor's Viewpoint," which has been prepared by Mr. S. Waugh. The author suggests that, although the importance of the supervisor's position is acknowledged to the full to-day, the supervisor himself does not always know his place in industry. He must know, the booklet says, what constitutes the organisation to which he belongs, the contributions of all the various departments and sections and how they help him to do his job, the necessity for periodic moves and minor upheavals, and the need for control.

A foreword to the booklet points out that "sound knowledge of organisational practice is not only essential to the supervisor for the efficient performance of his immediate functions, but also forms an unconscious preparation for higher responsibilities." The booklet, which costs 2s. 6d., can be obtained from the Institute of Industrial Supervisors, 47, Temple Row, Birmingham, 2.

Changes in Wage Rates

The Ministry of Labour states that changes in wage rates reported as coming into operation during May resulted in an aggregate increase of £213,000 in the weekly full-time wages of about 816,000 workers. Among those receiving increases were employees in the iron and steel industry—under sliding-scale arrangements based on the cost-of-living index—workers employed in civil engineering construction in certain districts, and those employed in paper-making.

In civil engineering construction the highest provincial grade rate of wages was adopted for all areas of Great Britain outside the London area, and there were consequential increases of a halfpenny, a penny and three-halfpence an hour for workers affected by the regrading. In the first five months of this year changes in wage rates led to an aggregate increase of £2,463,300 in the weekly wages of 6,395,500 people, compared with increases amounting to £374,000 in the weekly wages of 2,268,000 people in the corresponding months of 1950.

The National Coal Board

The Minister of Fuel and Power, Mr. Noel-Baker, stated in the House of Commons on Monday that the present appointments of the Chairman and the full-time members of the National Coal Board would expire on July 15th. He then announced that Lord Hyndley had intimated his intention to retire from the chairmanship and from the Board.

The Minister said that when Lord Hyndley accepted the post as Chairman in 1946, he made it clear that he could not promise to serve the full period for which the appointment was made. It had been only at the earnest request of the Government, and from a great sense of public duty that Lord Hyndley had carried the heavy burden of the chairmanship for the full term. The Minister then expressed the Government's thanks and appreciation to Lord Hyndley and the other members of the Board for the great public service they had rendered.

The Minister went on to say that, following Lord Hyndley's retirement, the National Coal Board was to be reconstituted as follows:—Chairman, Sir Hubert Houldsworth; Deputy Chairmen, Mr. W. J. Drummond and Sir Eric Coates; full-time members, Mr. Ebby Edwards, Sir Charles Ellis, Sir Geoffrey Vickers and Sir Andrew Bryan; part-time members, Mr. J. H. Hambro, Sir Geoffrey Heyworth, Mr. Gavin Martin, Sir Godfrey Mitchell and Alderman Sidney Jones. The existing appointments, the Minister stated, would continue until the end of July, and the new appointments would, therefore, date from August 1st.

The newly appointed Chairman, Sir Hubert Houldsworth, has been Chairman of the East Midlands Division of the National Coal Board since 1946.

Notes and Memoranda

Air and Water

RADIO RANGES.—Australia is to double its radio range navigational aid facilities at a cost of approximately £A.820,000. It was stated that such route guidance would serve Australia's needs for the next ten years, even considering the rapid developments in other electronic aids.

BLADE STRESSING.—An attempt is now being made by Rolls-Royce, Ltd., to analyse the stressing of gas turbine blading during flight. Fitted to the turbine blading are electrical strain gauges, which are used in conjunction with a radio transmitter and a ground based magnetic tape recorder. This record, when suitably converted, can be used to present a continuous graphical picture of the stress characteristics on a cathode ray tube display. Simultaneous observations of a crew member can similarly be recorded with the same time base.

Miscellanea

"HOUSING MANUAL, 1949: TECHNICAL APPENDICES."—The companion volume to the latest "Housing Manual" has recently been published by H.M. Stationery Office with the above title. It has been compiled by the Ministry of Works and seeks to establish a minimum code of good practice in the construction of all types of dwelling.

DOLLAR EXPORTS.—The Dollar Exports Advisory Council, which has been formed under the chairmanship of Sir William Rootes, took over the functions of the Dollar Export Board on July 1st. The Council's task is to direct policy for the promotion of greater trade between this country and North America. Its executive committee includes senior officials of the organisstions which have sponsored the Dollar Export Board and initiated the establishment of the trade promotion centres in New York and Toronto. The offices of the Council are at 41, Buckingham Palace Road, London, S.W.1 (telephone, Whitehall 6711).

HOT STRIP MILL AT MARGAM.—The Steel Company of Wales, Ltd., has announced that its 80in continuous hot strip mill at Abbey Works, Margam, has been successfully started and the first phase of testing and operation under full load conditions is gradually changing over to production. One shift is at present being worked and it is expected that two shift workings will begin within a few weeks. The cold reduction plant for the manufacture of sheet at the Abbey Works is not programmed to start operation until the late summer and the tinplate plant at Trostre until the autumn, so in the meantime the coils produced on the hot strip mill are being sent to other cold reduction plants for rolling and finishing.

THE LATE MR. R. F. MCKAY.—We regret to record the death, at the age of sixty-seven, of Mr. Robert Ferrier McKay, who was manager of Dunlop's inventions and patents department until his retirement last year. Mr. McKay joined Dunlop in 1926 as an engineer in the department formed for the development of the new technique of electrically depositing natural rubber latex by the anode process. He was the author of books on "The Theory of Machines" and "The Principles of Machine Design," and was a lecturer in engineering at the City and Guilds College, an examiner for B.Sc. (Eng.), London and Benares Universities. Mr. McKay was a member of the Institution of Mechanical Engineers and an associate member of the Institution of Civil Engineers.

INTERNATIONAL MANAGEMENT CONGRESS DELEGATION.—Dame Caroline Haslett, D.B.E., J.P., a member of the British Electricity Authority, will head a delegation from the Authority to the ninth Congress of the International Institute of Management, which is to be held at Brussels from July 5th to 11th inclusive. The delegation includes Mr. E. R. Wilkinson, commercial manager; Mr. E. Long, a deputy chief accountant; Mr. T. Mainprise-King, an assistant director of establishments; Mr. E. Butterworth, secretary of the Merseyside and North Wales Division, and Mr. R. S. Atkinson, generation engineer (operation) of the South Eastern Division. Dame Caroline will be attending the congress in a dual capacity, since she is a member of the Council of the British Institute of Management.

THREADING DIES.—A new publication entitled "The Robertson Guide to Threading Dies," has been received from W. H. A. Robertson and Co., Ltd., of Lynton Works, Bedford. In this book details are given of more than 300 types of British, American and Continental dies for dieheads, screwing machines and handstocks. Useful technical data given in the book covers radial and tangential dies and a comparison of the principal screw thread systems of the world, including the Unified System with the latest amendments. Comprehensive tables of helix angles, depth of threads, cutting speeds and extensive metric conversion tables are included. Attention is drawn to the firm's service for recutting and regrinding dies.

SCOTCH DERRICK CRANES.—Following three accidents in quarries as a result of the collapse of Scotch derrick cranes, the Minister of Fuel and Power has sent a special letter to quarry owners and workers associations. In this letter it was stated that two of the accidents had been caused by the failure of a cracked gland iron, which had been repaired by welding, and the third by the breakage of an iron, which had been partially fractured for some time. The Minister was advised that it was difficult, if not impossible, to make a sound repair by welding a cracked gland iron and that no gland iron should be repaired by welding. The letter went on to advise that cranes now in service should be specially examined by a competent person to discover whether the gland iron is cracked or has been repaired by welding.

THOMAS DE LA RUE EXHIBITION.—Thomas de la Rue and Co., Ltd., London, are holding an exhibition at 26, Conduit Street, W.1, which commenced on Monday last and will remain open until July 19th. Products representing the company's activities since 1821 include frames of postage stamps and banknotes, modern fountain pens, playing cards, diaries, plastic laminates and extrusions, and gas appliances. Thomas de la Rue, founder of the company, came to London in 1818 and was responsible for the development shortly afterwards of the mineral, barytes white, which imparts to rough printing card a high gloss finish. The company began printing playing cards in 1826, and later, in 1853, introduced surface printed stamps by the letterpress method. With this method also the company produced its first banknotes in 1864, and was later to lay the foundations of modern security printing. Many examples of this early work may be seen.

NEW LONDON SHOWROOMS OF BURTON, GRIFFITHS AND CO., LTD.—Some time ago the rapid expansion of the activities of Burton, Griffiths and Co., Ltd., made desirable the acquisition of new and more extensive premises in London, where showrooms would be available for overseas and home visitors, and where demonstrations could be given and large stocks of tools could be maintained. For this reason, the company acquired the premises of the Leo C. Steinle company, at 93, Albert Embankment, S.E., and re-equipped them as a showroom and office. In this building office facilities have been provided for overseas visitors who may wish to conduct their business from London, where they can have direct contact by teleprinter service with the various works of the Group and be in telephone communication with their own works abroad. Staff is provided as may be required. The main showroom floor has a large control demonstration area set below the general floor level and in this area sufficient space is provided to demonstrate a number of machines on actual production under workshop conditions, either singly or in groups. The floor surrounding the demonstration area is fitted with showcases containing a wide selection of small tools and other equipment. A staff of skilled technicians is available at all times to advise potential customers and demonstrate the machines.

OBITUARIES.—We regret to report the deaths recently of Mr. F. S. Holder, formerly of Metropolitan-Vickers Electrical Export Company, Ltd., and of Mr. E. A. Guthrie, manager of the American Division of the same company. Mr. Holder was born in 1882 and was educated at Adelaide. He joined the old British Westinghouse Company in 1906 and in May, 1907, went to South America as one of the company's first overseas representatives. In 1919 he was appointed to represent the newly-formed Metropolitan-Vickers Electrical Export Company, Ltd., at the Trafford Park Works, and in 1923 he transferred to the London office, where he remained until his retirement in December, 1949. Mr. Guthrie was born in 1892 and received his technical education at Dublin, Liverpool and Manchester College of Technology. He came to the British Westinghouse Company as a school apprentice in 1910 and passed through the motor, traction and erection departments. After periods with Switchgear and Cowans, Ltd., and Ferguson Pailin, Ltd., he returned to Metropolitan-Vickers in 1920 as a switchgear engineer. In 1935 Mr. Guthrie joined the Metropolitan-Vickers Electrical Export Company as a sales engineer at the London office and in 1947 he transferred to the South American Division. He was appointed manager of the American Division of the Metropolitan-Vickers Electrical Export Company, Ltd., on January 1, 1948.

Personal and Business.

THE COAL UTILISATION JOINT COUNCIL states that its offices have been moved to 3, Upper Belgrave Street, London, S.W.1 (telephone, Sloane 9116).

MR. F. J. B. HENDERSON, Mr. C. H. Carslaw, A.M.I.Mech.E., and Mr. T. L. Mackie, A.I.Mar.E., have been appointed additional directors of Drysdale and Co., Ltd., Yoker, Glasgow.

MR. LEWIS CHAPMAN, managing director of William Jessop and Sons, Ltd., has been appointed chairman of the Birtley Company, Ltd., Birtley, Durham, in succession to the late Mr. E. H. W. Cooke.

E. H. JONES (MACHINE TOOLS), Ltd., has been appointed agent in Great Britain and Eire for the range of A–I machine tools produced by Netherlands Engineering Works "Arillerie-Inrichtingen," Ltd., Hembrug, Zaandam, Holland.

FERODO, Ltd., states that Mr. J. D. Millner has been appointed manager of its North London depot at Handel Street, W.C.1, in succession to Mr. L. A. Potter. Mr. E. B. Knee succeeds Mr. Millner as manager of the South London branch at Clapham, and Mr. F. E. Perryman takes Mr. Knee's place as depot manager at Bristol.

LANCASHIRE DYNAMO HOLDINGS, Ltd., announces that its registered office is now at 94, Petty France, London, S.W.1. The registered office of its subsidiary, Lancashire Dynamo and Crypto (Mfg.), Ltd., is also at that address. The latter company is now wholly responsible for the activities of the Trafford Park and Willesden works.

THE BRITISH WELDING RESEARCH ASSOCIATION announces the following staff changes:—Dr. Nicol Gross, A.M.I.Mech.E., becomes assistant director of research, continuing his responsibility for engineering researches and remaining in charge of the Abington research station; Dr. K. Winterton and Mr. H. E. Dixon become chief metallurgists for ferrous and non-ferrous metals respectively, and Mr. C. L. M. Cottrell and Mr. P. T. Houldcroft have been appointed assistant chief metallurgists.

THE IRON AND STEEL CORPORATION OF GREAT BRITAIN has notified the Birmingham Small Arms Company, Ltd., of its intention to exercise its option to acquire the steel interests of the Birmingham Small Arms Group, consisting of Wm. Jessop and Sons, Ltd., J. J. Saville and Co., Ltd., and Bromley Fisher and Turton, Ltd. Negotiations on price and date of transfer are proceeding between the representatives of the Corporation and the Birmingham Small Arms Company, Ltd.

THE IRON AND STEEL CORPORATION OF GREAT BRITAIN announces the following changes in the boards of three publicly owned companies:—The Kettering Iron and Coal Company, Ltd., Kettering: Mr. F. Scopes has been appointed director and chairman in succession to Mr. James Gough, who has resigned; the New Cransley Iron and Steel Company, Ltd., Kettering: Mr. H. J. Ellison, chairman and managing director, has retired, and Mr. F. Scopes has been appointed chairman, Mr. G. H. Johnson having been appointed managing director; Glynhir Tin Plate Company, Ltd., Pontardulais, Glamorgan: Mr. Edward Withington and Mr. N. W. Fischer have retired from the board; Mr. W. S. G. Rees has been appointed chairman, and Mr. O. J. Thomas, Mr. Ivor Lewis, and Mr. E. Arthur Withington have been appointed directors.

Launches and Trial Trips

ATHELTEMPLAR, molasses tanker; built by Joseph L. Thompson and Sons, Ltd., for the Athel Line; length between perpendiculars 465ft, breadth moulded 63ft 3½in, depth moulded 35ft 10in, deadweight 12,875 tons; load draught 28ft 3in; N.E.M.-Doxford oil engine, four cylinders 670mm diameter by 2320mm combined stroke, 12¼ knots. Launch, June 19th.

British Patent Specifications

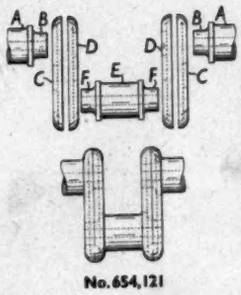
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application: the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

POWER TRANSMISSION

654,121. June 10, 1948.—The Manufacture of Crankshafts, Richardsons, Westgarth and Co., Ltd., of Northumberland Engine Works, Wallsend-on-Tyne, Northumberland; Harry Hunter, of 1, Graham Park Road, Gosforth, and James Andrew Dorrat, of 1, Towers Avenue, Newcastle upon Tyne, 2.

This invention concerns an improved method of manufacturing crankshafts for reciprocating engines. The drawings illustrate stages in the method of manufacturing a simple welded crankshaft according to the invention. The crankshaft comprises a pair of journals *A* each formed with end spigots *B* adapted to be received and welded within the opposite openings formed in a pair of outer web



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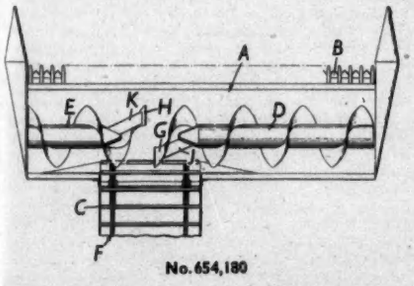
sections *C* and a pair of inner web sections *D*. The webs are joined by a crank pin *E* formed with spigots *F* at each of its ends, which are similarly welded in openings in the web sections *C* and *D*. Each of the web sections is substantially flat with a flange extending partly or continuously around its edge, the two halves of each web being complementary in shape so that when placed face to face a hollow space is produced which is suitable for receiving some form of counterbalancing weight. In the assembly of the crankshaft the spigots of the journals are inserted in their corresponding openings in each of the outer web sections and butt welded. The spigots on the crank pin are inserted and welded in corresponding openings in each of the inner web sections. The web sections are then machined so that their faces are square with the crank pin or journals and are assembled and tack welded. This part of the assembly is facilitated by the protrusion of the spigots into the web sections. The provision of the spigots on the journals and the crank pin ensure accuracy of the throw of the crank, while the comparatively large area round the web flanges gives the strength necessary to hold the journals in line. Various modifications for oval webs and counterbalancing weight are shown in the specification.—June 6, 1951.

AGRICULTURAL ENGINEERING

654,180. January 30, 1948.—Conveying Means for Harvesters, The International Harvester Company of Great Britain, Ltd., of 259, City Road, London, E.C.1. *Communication by the International Harvester Company, of* 180, *North Michigan Avenue, Chicago, Illinois, U.S.A.*

As shown in the drawing, a harvester platform *A* having swath separators at the outer sides is



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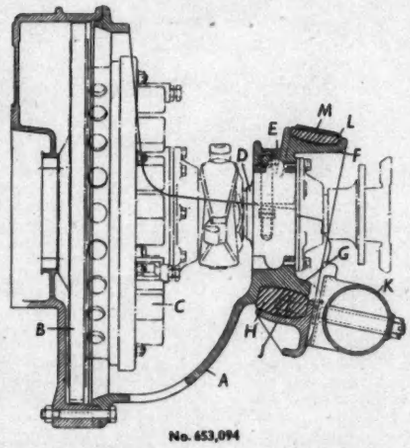
provided at its forward edge with a cutter bar *B* for cutting standing grain, the grain falling rearwards on to the platform as the harvester progresses. The platform is also provided with a relatively narrow portion *C* extending upward and rearward. The cut grain is conveyed along the platform to a position opposite the narrow portion by oppositely acting auger conveyors *D* and *E*. Each conveyor terminates opposite the narrow portion *C* associated with which is a cross-slat conveyor *F*, which elevates the grain to threshing or other mechanism. It will be seen that the flights, instead of terminating at the tapered delivery ends of the cores of the auger conveyors, are extended towards each other to form paddle elements *G*, *H*, the ends of which move in transverse planes the distance between which is very small. Brace members *J*, *K* support the outer ends of the paddle elements. These brace members provide sufficient reinforcement for the paddle elements so that they are capable of effecting movement of the conveyed material in a lateral direction with respect to the auger conveyors to the elevator conveyor *F*. This type of conveying means may be used with various kinds of harvesters, such as harvester threshers, straw balers and the like.—*June* 6, 1951.

AUTOMOBILE ENGINEERING

653,094. June 11, 1948.—Flexible Mounting for a Vehicle Engine, Guy Motors, Ltd., of Fallings Park, Wolverhampton; and Glyn Pierce Roberts, of the company's address.

In the drawing *A* is the usual bell housing at the rear end of the engine of a motor vehicle which houses the flywheel *B* and clutch *C*, and is extended rearwards to provide a support bearing for the output shaft *D*. The bearing support *E* is formed above and below its axis with seatings *F* and *G* for the rubber pads of the mounting. The surface of each seating is of concave form and the upper seating has shallow flanges on its front and rear edges. The lower seating is provided on its front and rear edge with a number of angularly spaced, downwardly extending fingers, the fingers on the rear edge being staggered or offset relative to those



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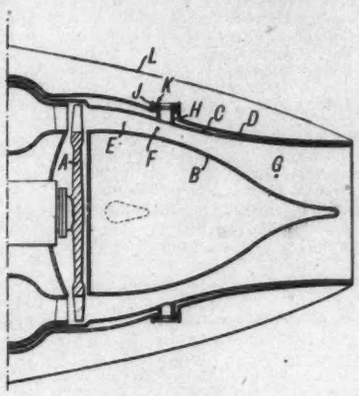
on the front edge. An arcuate rubber pad *H* is interposed between the lower seating and a complementary seating *J* on a bracket which is mounted on a tubular cross member *K* of the vehicle chassis and supports that part of the weight of the engine which is not carried by the front mounting. Another arcuate rubber pad *L* of less radial thickness than the pad *H* is received in the upper seating on the bearing support, and fitting over this pad is an adjustable tensioning means comprising a flat steel strap *M*, of which the ends are connected by loops. Any angular movement of the engine relative to the fixed part of the mounting causes substantially radial compression of the rubber pads at diametrically opposed ends and, while the torsional resistance of the mounting is relatively small for movements of a few degrees to either side of the normal position, it increases rapidly with increase in the amplitude of the movements.—*May* 9, 1951.

AERONAUTICAL ENGINEERING

654,344. November 18, 1948.—Regulating Gas Turbine Jet-Propulsion Plants, Compagnie Electro-Mecanique, of 12, rue Portalis, Paris (Seine), France.

The invention constitutes a method of regulating gas turbine jet-propulsion plants. It involves a control of the effective sectional area of the jet nozzle of the plant by influencing the operating conditions of the nozzle without altering its actual geometrical area. As shown in the drawing, the propulsion nozzle is of the convergent-divergent type due to the combined shapes of the inner fairing and of the outer wall of the nozzle, and the general outer shape of the nozzle is simply convergent. *A* is the turbine wheel, *B* the inner fairing which streamlines the disc of the turbine, *C* the outer wall of the nozzle, and *D* an additional wall to provide for the circulation of cooling air. *E* is the convergent section of the nozzle, *F* the throat and *G* the divergent section. Immediately below the throat are the air intake apertures *H*. These communicate with the atmosphere through a fixed ring *J* welded to the wall *D*. Surrounding the ring is an annular damper *K* which can be rotated about its axis and which is provided with apertures dimensioned



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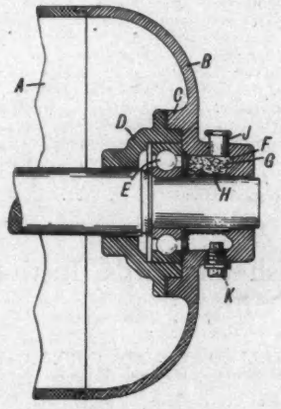
and arranged the same as the apertures *H*. Depending on whether the apertures in the annular damper *K* are or are not in register with the air intake apertures *H* they are open or closed. The drawing indicates the outline *L* of the fuselage of the aeroplane or the fairing of the engine nacelle. The space between *L* and *D* is not fluid-tight so that suction through the apertures *H* is not interfered with. Additional air intake apertures similar to apertures *H* may also be provided in the divergent section *G* of the nozzle at the point where expansion is completed in altitude flight. These apertures may then be connected with manifolds adapted to suck the boundary layer on the fairing *L* in accordance with a known arrangement.—*June* 13, 1951.

BEARINGS AND SUPPORTS

654,234. September 5, 1945.—Lubrication of Anti-Friction Bearings, particularly for Electric and like Machines, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

The drawing shows the bearing on a dynamo-electric machine having a stationary frame *A* and an end shield *B* adapted to support a bearing for a shaft on which the armature is mounted. The end shield is formed with an inwardly extending circular flange *C*, to which a bearing cap *D* is secured. An anti-friction ball bearing *E* in the bearing cap supports the shaft. The bearing cap, the flange and



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an outwardly extending lubricant supply chamber *F* form a bearing housing, and lubricant supply reservoir, for gradually feeding oil to the ball bearing without flooding it, and without supplying an excessive amount of oil which might cause foaming. This is accomplished by providing an oil-absorbent fibrous waste material *G* within the chamber *F* and held out of contact with the shaft by a wall formed by a cylindrical element *H* mounted in the chamber and formed to provide for the passage of the shaft. This waste material is held out of contact with the bearing *E* by a perforated member having passageways which permit the passage of oil from the chamber to the

bearing and also provides for a return of this oil when the bearing is in operation. An oil cup *J* which extends through the upper part of the chamber and an adjustable overflow fitting *K* in the lower part of the chamber are provided.—*June 13, 1951.*

MISCELLANEOUS

653,875. August 10, 1948.—FLUID STORAGE TANKS, Arthur Harold Stevens, of the firm of Stevens, Langner, Parry and Rollinson, Chartered Patent Agents, of 5–9, Quality Court, Chancery Lane, London, W.C.2. *Communicated from The Chicago Bridge and Iron Company, of 1305, West 105th Street, Chicago, Illinois, U.S.A.*

This invention relates to a storage tank specifically designed to withstand internal pressure. The drawing shows part of a liquid storage tank having a flat bottom, cylindrical side walls and a domed or cone roof. Secured to the inner portion of the side walls is a ring compression member in the form of an angular girder *A* welded to the walls

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and extending about the interior of the tank on a horizontal plane. Welded to this member are radial stress members *B* having their opposite ends secured to the bottom of the tank. Each stress member comprises a steel girder having generally the shape of a catenary. Secured to the bottom of the tank are circumferential stiffeners *C*, as shown, of angle irons formed into a circle and welded to the bottom. If desired, the circumferential stiffeners may be in the form of arcs of a circle rather than complete circles, as shown. A number of vertical tie members *D* have one end welded to the stiffeners and the other end welded to the catenary. The catenary is employed only to strengthen the side walls and the bottom, but a second catenary can be attached to the side walls and the roof to strengthen them. Various designs of tanks embodying this construction are shown in the specification.—*May 30, 1951.*

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

ENAMELLED ROUND COPPER WIRE
(Oleo-Resinous Enamel)

No. 156 : 1951. This new edition of B.S.156 differs from the 1943 edition, which was entitled "Enamelled High-conductivity Annealed Copper Wire," in that it has been extended to include the full range of wire sizes from 0·001in to 0·160in, inclusive. It gives details of diameters, resistances and thickness of enamel (including tolerances), together with tests on the enamel insulation. These tests relate to hardness, flexibility and adherence, heat shock, cold test at 0 deg. Cent., heat ageing and electric strength. The standard sizes of wires complying with this specification are given in s.w.g. and in an appendix are given details of a range of wires complying with Brown and Sharpe gauges; provided that wires to these gauges comply in all other respects with the requirements of this standard, they may be deemed to comply with this British Standard. Price 3s., post free.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Incorporated Plant Engineers

Wed., July 11th.—E. LANCS. BRANCH: Visit to Small and Parkes, Herdham Vale, Manchester, 12.45 p.m., for lunch, afternoon visit and tea.

Thurs., July 12th.—NEWCASTLE UPON TYNE BRANCH: Roadway House, 8, Oxford Street, Newcastle upon Tyne, "Oil in Industry," I. A. Howden, 7.30 p.m.

Wed., July 18th.—E. MIDLANDS BRANCH: Evening Visit to General Refractories, Ltd., Worksop.

Sat., July 21st.—BIRMINGHAM BRANCH: Morning Visit to B.E.A., Hams Hall "B" Station.

Institute of Industrial Supervisors

Sat., July 7th.—Rubery Owen and Co., Ltd., Darlaston Green, Darlaston, South Staffs. Regional Conference on "Supervision and Materials Handling."

Institution of Mining Engineers

To-day, July 6th.—Summer Meeting, Nottingham.

Institution of Sanitary Engineers

To-day, July 6th.—Caxton Hall, Westminster, S.W.1, Annual General Meeting, 5.15 p.m., "From Thames to Tap," Gordon Carter, 6 p.m.

Sat., July 7th.—Visit to Metropolitan Water Board Laboratories, New River Head, Rosebery Avenue, E.C.1, 9.45 a.m.

Old Centralians

Fri., July 13th.—Chez Auguste Restaurant, Frith Street, W.1, "Engineering Potentialities and Opportunities in Afghanistan," W. Abbott, 12.55 p.m.

Royal Meteorological Society

Wed., July 18th.—Summer Meeting at East Malling Research Station, East Malling, Maidstone.

Technical Reports

Rates of Rise of Restriking Voltage at Circuit Breaker Positions on 66kV Systems (System B) (Ref. G/T235). By L. Gosland, B.Sc., M.I.E.E., and H. Goldenberg, B.Sc. The British Electrical and Allied Industries Research Association. Price 4s. 9d., post free.—E.R.A. report Ref. G/T227 gave the results of calculations of rate of rise of restriking voltage for most of the circuit breakers on a particular 66kV system. The present report continues this work by giving similar data for a second 66kV system. It is intended to proceed eventually to cover all 66kV systems in Great Britain in this way. The calculations are intended to cover the most severe conditions which can arise at each installation and in all cases relate to the interruption of fault current when all feeders on the system other than those constituting a link between the fault and generating plant have been disconnected. The condition considered is that at the clearance of the first phase of a three phase fault, not to earth.

Application of Electrical Steam Generators to the Sterilising of Dairy Equipment (Ref. W/T19). By C. A. Cameron Brown, B.Sc., M.I.E.E., A. S. Hall, B.Sc., N.D.A., and P. Wakeford, A.M.I.E.E. The British Electrical and Allied Industries Research Association. Price 6s. 3d., post free.—The purpose of the investigation described in this report was to determine the best methods of utilising and handling electrical steam raising equipment. This work involved temperature/time measurements for a range of steam sterilising processes carried out with a variety of electrical steam raising appliances. From these determinations and by direct measurement, quantities of steam required for various processes were assessed and the optimum evaporation rates determined. Tests to determine the steam capacity of storage plant and the radiation and other losses to be expected in daily use were also involved. This work made it possible to assess the limits of use of the classes of equipment, as well as to classify steam quantites for different purposes.

Rates of Rise of Restriking Voltage at Circuit Breaker Positions on 66kV Systems (System C). (Ref. G/T236). By L. Gosland, B.Sc., M.I.E.E., and J. S. Vosper, B.Sc. (Eng.). The British Electrical and Allied Industries Research Association. Price 7s. 9d., post free.—This is the third report of this series and deals with the circuit breaker positions in the substations of a third system (C). The results here presented were obtained experimentally on a model network arranged to represent the most severe conditions which can arise at each circuit breaker location. They relate to the interruption of fault current when all feeders on the system other than those constituting a link between the fault and generating plant have been disconnected. The condition considered is that of the first phase to clear on a three phase fault, not to earth, on the assumption that the power frequency peak recovery voltage is 1·5 ($\sqrt{2}$ line voltage)/$\sqrt{3}$.

"Heat Developed" and "Powder" Lichtenberg Figures, and the Ionization of Dielectric Surfaces produced by Electrical Discharges. (Ref. L/T232). By A. Morris Thomas, B.Sc., F.Inst.P., M.I.E.E. The British Electrical and Allied Industries Research Association. Price 9s. 3d., post free.—A brief outline of the characteristics of Lichtenberg figures is given and some experiments on "heat developed" and "powder" figures are reported. It is shown that "heat developed" figures can be produced only on a restricted range of solid dielectrics and are associated with the state of the surface. The effect of repetition of impulses on alternating polarity is investigated by means of "powder" figures. A difference between Lichtenberg figures produced by negative impulses of short and long wave front and tail is demonstrated and an explanation based on the theory of spark discharge is given.

Dielectric Properties of Ketones (Ref. L/T249). By V. Daniel, Ph.D., F.Inst.P., and K. H. Stark, B.Sc., A.Inst.P. The British Electrical and Allied Industries Research Association. Price 7s. 9d., post free.—This report is a continuation of report Ref. L/T200 and is concerned with the experimental verification of Fröhlich's theory of the dielectric properties of normal long-chain ketones, based on the known crystal structure of these materials, whereby he predicts an essentially ferroelectric order-disorder transition associated with high values of the dielectric constant.

Books of Reference

"Gas Journal" Calendar and Directory, 1951. London: Walter King, Ltd., 11 Bolt Court, Fleet Street, E.C.4. Price 25s. net.—As in previous editions of this reference book, the first section comprises a directory of undertakings, councils, boards in this country and other commonwealth countries with particulars of the personnel, plant, output, &c. The second part of the volume is a memorandum on gas works practice with general information and tables for daily reference in the gas and allied industries. A useful buyers' guide is also included in the book.

The Export Group for the Constructional Industries Directory, 1951. London: The Export Group Offices, 82, New Cavendish Street, W.1.—This directory is designed to assist those concerned with the planning of civil engineering works, building and other constructional work outside of the United Kingdom. It deals in some detail with the background of the various firms within the group, and gives particulars of the various classes of construction they undertake such as bridges, aerodromes canals, docks, housing, &c. The scope of most of the firms' activities is illustrated by brief particulars of some of the more recent contracts carried out or in hand at home and in various parts of the world. Lists of representatives in other countries are given to assist overseas users of the directory. The detailed nature of the information given in the book will make it of particular interest to governments, municipalities and public and private corporations abroad.

DISTRICT HEATING.—In the interim report of the working party set up by the Minister of Health in March, 1948, to consider district heating in relation to public water supplies, which has been issued by the Ministry of Local Government and Planning, it is unanimously recommended that all district heating schemes should be designed to supply heat and hot water by the indirect rather than by the direct method. In this indirect method of district heating hot water or steam is circulated through a closed system of pipes and water is heated in individual calorifiers in the houses or flats. The heating coil of the calorifiers forms part of the closed circuit of the district heating scheme. By the use of this method the amount of hot water available to a household at any one time is limited and depends chiefly on the capacity of the calorifier. All the water used in the home is drawn from the cold water service pipe connecting the home with the water undertaking's supply main. The district heating authority's mains supply heat only and the tap-water is heated inside each home. In the direct method of district heating, hot water is supplied directly to the taps of individual homes by flow and return mains, which carry the hot water from a central heating station. There is also a separate system of pipes forming a closed circuit for the space heating of the houses.